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FOR THE YEAR

## 1906.

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PUBLIC DOCUMENT . . . . . . . . No. 34.

# THIRTY-EIGHTH ANNUAL REPORT

OF THE

# STATE BOARD OF HEALTH

OF

# MASSACHUSETTS.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1907.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

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## 1906.

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# GENERAL REPORT.

The following report, in accordance with the provisions of chapter 211 of the Acts of 1905, covers the work of the State Board of Health for the period ended Nov. 30, 1906, which date concludes the fiscal year established by that act. In anticipation of the change, the annual report of the Board for 1905 covered the work done in the field of water supply and sewerage for the eleven months ended November 30 of that year, rather than as in preceding reports, for the year ended December 31. The present report, therefore, deals with the work of that department for the twelve months ended November 30. Previous reports have covered the work performed in the food and drug laboratory during the year ended September 30, and the annual report for the year 1905 brought the work of the diagnosis laboratory and the report on the production, distribution and use of vaccine and diphtheria antitoxin and on inspection of dairies down to the same date. This report deals with the work of these several laboratories during the fourteen months ended November 30. In accordance with the provisions of the act above mentioned, the work of all of the departments of the Board will in future be reported upon to the common date mentioned.

On account of the fact that, when the report of the Board for the year 1905 was prepared and submitted, the annual reports of local boards of health had not been issued and would not be available for some months, the usual report on "Health of Towns" was omitted. For the same reason the customary reports on "Fatality of Certain Diseases," "Official Returns of Deaths in Cities and Large Towns," and "General Health of the State," were necessarily deferred. All of these are presented in this report in the Supplement, in which are included also the details of the work of the various departments, together with articles on special subjects.

### Tuberculosis Exhibition.

The Legislature of 1905 passed a resolve providing for an "Exhibition Illustrative of the Means and Methods for the Treatment and Prevention of Tuberculosis," and a report thereon was made to the Legislature of 1906, as follows: —

## I. Introductory.

The Legislature of 1905 passed the following resolve: —

Chapter 75, Resolves of 1905.

Resolve to provide for an Exhibition of Means and Methods of Treating and Preventing Tuberculosis.

*Resolved,* That the state board of health is hereby authorized, within two years after the passage of this resolve, to cause a public exhibition to be made of the various means and methods used or recommended for treating and preventing tuberculosis, now recognized as a communicable and preventable disease. The said board may expend a sum not exceeding two thousand dollars in carrying out the provisions of this resolve, and is directed to report to the general court on or before the fifteenth day of January next following said exhibition, and shall accompany its report with any recommendations for legislation which it may deem advisable. [*Approved May 12, 1905.*

In accordance with the provisions of this resolve an exhibition was held under the direction of the Board in Horticultural Hall, Boston, from Dec. 28, 1905, to Jan. 7, 1906, inclusive.

## II. Preliminary Work.

The purpose of the exhibition being essentially educational, it was deemed wise to obtain the co-operation of persons whose relations with the community enabled them alike to assist the Board in arousing public interest in the exhibition and to advise with regard to its management.

To this end there was constituted an auxiliary committee, composed of the following: —

Henry Abrahams, Boston, secretary Cigarmakers' Union.
Nathan D. Bill, Worcester.
Samuel H. Brophy, Boston.
Dr. Vincent Y. Bowditch, Boston.
Dr. Rocco Brindisi, Boston.
Dr. Arthur T. Cabot, Boston, president Massachusetts Medical Society.
Dr. H. Lincoln Chase, Brookline.
Dr. W. T. Councilman, Boston.
Dr. Samuel H. Durgin, chairman Boston Board of Health.
Dr. Harold C. Ernst, Boston.
Dr. Albert C. Getchell, Worcester.
Hon. Charles S. Hamlin, Boston.
Hon. J. C. Hammond, Northampton.
Alice L. Higgins, Cambridge.
William A. Hovey, Boston.
Mary Morton Kehew, Boston.
Dr. Walter J. Marcley, Rutland Sanatorium.
George A. Martin, secretary Massachusetts State Board of Education.
Dr. James J. Minot, Boston.

Dr. Edward O. Otis, Boston, president Boston Association for the Relief and Control of Tuberculosis.
Dr. Charles H. Page, superintendent Danvers Insane Hospital.
Robert Treat Paine, Jr.
Gen. Thomas Sherwin, president New England Telephone and Telegraph Company.
Dr. Arthur K. Stone, secretary Boston Association for the Relief and Control of Tuberculosis.
John J. Tobin, president Boot and Shoe Workers' Union.
Helen A. Whittier.
Alexander M. Wilson, secretary Boston Association for the Relief and Control of Tuberculosis.
Robert A. Woods, Boston.
Sarah Yerxa, Cambridge.

This committee met on November 21, in conference with the chairman and the secretary of the Board. Plans for the management of the exhibition were discussed, and it was decided that there be held in connection with the exhibition a series of public meetings, at which should be presented and discussed by appropriate speakers the opportunities for effort in the prevention of tuberculosis, and the methods of its treatment and cure.

Faneuil Hall was at first selected as an exhibition place, and was secured for that purpose. It was found, however, upon calculating the space needed for the various exhibits, that this hall was too small; that to assemble and properly display here all of the exhibits would preclude the use of the hall as an auditorium. The engagement of this hall was consequently cancelled, and Horticultural Hall was chosen in its stead. Here there were available two exhibition halls of ample size, and a lecture room seating over 500, directly adjoining the main exhibition hall.

The entire problem of the exhibition and its management was then carefully studied. Detailed specifications were drawn, which made provision as definitely as possible for giving public notice of the exhibition, for the transportation of the material, for the preparation of the exhibition hall, for the installing of the exhibits, for the organizing of an administrative staff, and for the making of arrangements for special meetings and lantern-slide demonstrations.

## III. Publicity.

In order to bring the exhibition, with its objects, prominently before the people of the Commonwealth, the following printed matter was prepared and distributed: —

*A.* An announcement, in the form of a four-page circular, setting forth the time and place of the exhibition, its origin, its purpose, a program of the special meetings, and the membership of the State Board of Health and of the auxiliary committee.

*B.* Circular letters addressed to the following: —

1. Physicians: members of reputable medical societies, throughout the State.

2. Philanthropists: secretaries of charitable and benevolent societies throughout the State, clergymen of all denominations.

3. Boards of health of cities and towns.

4. Institution managers, including the superintendents and trustees of hospitals, public and private, asylums, almshouses, reformatories and homes throughout the State.

5. Labor organizations: secretaries of labor unions.

6. Educators: superintendents of schools of all cities and towns, secretaries of school committees of all cities and towns, dean of every college and institution of higher learning throughout the State.

7. Employers: manufacturers, large store-keepers and others throughout the State.

8. Trained nurses: all such registered in the principal registries of Boston.

These letters, together with the announcement, were posted, one week before the exhibition opened, to about 12,000 persons, and the announcement alone to about 3,000 additional, — a total of 15,000 circulars sent through the mails.

*C.* Posters (24 inches by 36 inches) sent by mail to the board of health of every city and town in the State, and posted on the bill boards of all stations of the Boston Elevated Railway.

*D.* Small posters and cards printed in Hebrew, posted in the Jewish quarters and distributed among the Hebrews of Boston.

*E.* Small posters and a circular, printed in Italian, distributed among Italians.

*F.* Dasher posters, displayed on all street cars passing Horticultural Hall.

The co-operation of the public press was sought and obtained. All of the Boston newspapers published daily accounts of the progress of the exhibition, and satisfactorily full reports of the special meetings and of the lantern-slide demonstrations. On Sunday, December 24, the "Boston Herald" published an illustrated article on the exhibition. Reprints of this article were sent to 150 newspapers throughout the State, many of which republished it in full.

### IV. Material — Exhibits.

The material constituting this exhibition was in part collected by the National Association for the Study and Prevention of Tuberculosis (102 East Twenty-second Street, New York City), and loaned to the Commonwealth for use here, subsequent to its exhibition in the city of New York from Nov. 27 to Dec. 10, 1905.

Among the more important exhibits thus derived were those from the following sources: —

1. The Charity Organization Society of New York City (committee on tuberculosis): charts, statistical data, printed matter and photographs, setting forth the results of studies on tuberculosis conducted by the society in New York City, the educational methods which it employs, and the hospital for children under its management.

2. The Health Department of the City of New York: an extensive col-

lection of photographs, circulars printed in several languages, signs for use in public places, and models of hospital buildings and camps, illustrative of the work of the department in the treatment of consumptives at its free clinic, and in the Riverside Hospital; in the disinfection of premises vacated by tuberculous patients; and in the education of the public as to the danger from infected sputum.

3. Bellevue Hospital and allied clinics: photographs illustrative of the methods of treatment employed in its camp for tubercular patients.

4. The Loomis Sanatorium, Liberty, N. Y.

5. The Adirondack Sanatorium, Saranac, N. Y.

6. The Sunnyrest Sanatorium, White Haven, Pa.

7. The Agnes Memorial, Denver, Col.

8. The Henry Phipps Institute, Philadelphia, Pa.

Material more especially assembled for this exhibition included exhibits from: —

1. The Massachusetts State Board of Health: charts and statistical data showing the general decline in the death rate from tuberculosis in Massachusetts during fifty years; photographs of institutions having wards specially constructed for consumptives; data showing the hospital facilities for consumptives throughout the State, the number of cities and towns in the Commonwealth in which the registration of tuberculosis is required, and those which have ordinances against spitting in public places.

2. The Massachusetts State Sanatorium at Rutland.

3. The Sharon Sanatorium.

4. The Boston Association for the Relief and Control of Tuberculosis.

5. The Emmanuel Church Tuberculosis Class.

6. The Children's Hospital.

7. The Boston Instructive District Nursing Association. The exhibit prepared by this association consisted of two bed-rooms, 9 feet by 12 feet, one designed to represent the conditions often found by visiting nurses in the homes of the poor, — a typical tenement house sleeping-room; the other to show what may be done at a very slight cost, and under the direction of the nurse, to render such a room light, airy, clean and conducive to the health of the occupant.

8. Pathological and bacteriological exhibits. Exhibits demonstrating the bacteriology and the pathological anatomy of tuberculosis were submitted from the laboratories of the Harvard Medical School, the Boston University Medical School, and the State Board of Health.

The total number of exhibits was 96.

## V. Installation and Arrangement of Exhibits.

A survey of the material, made possible by a visit to the exhibition held in New York City, showed that nearly 5,000 square feet of wall space was needed for the proper display of exhibits adapted for hanging. To provide a suitable and adequate surface for such material, the walls of the main and of the lesser exhibition halls were faced with a screen 9 feet in

height, built of scantling covered with sheathing paper. In the large hall the mural space was increased by the building of additional screens placed at right angles with the walls, thereby forming numerous alcoves or booths. In one of the larger of these booths, at the rear of the hall, was placed the pathological exhibit. In another was conducted the microscopical demonstration of tuberculosis bacilli.

The general plan of arrangement of the exhibits was necessarily geographical. The material submitted for exhibition from each of the contributing sources was brought together and displayed in the same booth, or in adjoining booths, or in the same part of the hall.

So far as possible, models illustrative of hospital construction were placed in proximity to the photographic part of the exhibit to which they belonged.

Each of the large exhibits was plainly marked with a sign indicating its source.

In different parts of the main hall, and in prominent positions, were placed large cards bearing brief statements as to the nature of tuberculosis, and the value of fresh air and of sunlight in the prevention and treatment of the disease.

## VI. Administration.

The general direction of the exhibition was in charge of the secretary of the Board.

The administrative staff necessary for the handling of the material, including unpacking, installation, repacking and shipment, comprised the assistant to the secretary and three paid helpers working under his supervision. One of these helpers, who acted as first assistant, had charge of and operated the stereopticon used in the lantern-slide demonstrations.

The exhibition was open daily from 10 A.M. until 11 P.M. During these hours either the chief of the administrative staff or his assistant was present and in charge. At the door was constantly stationed a man to register attendance by tally disc, the attendance being recorded every two hours. A coat room for the use of guides and demonstrators was open at stated periods during the day and evening; when open, this room was in charge of one of the paid assistants. Between the hours of 7 and 10 P.M. a patrolman was stationed at the entrance to the hall.

A daily record was kept at the exhibition hall, in a book provided for the purpose. In this were entered notes as to weather, two-hourly records of attendance, estimated attendance at special meetings and demonstrations, etc.

## VII. Guides.

A corps of guides, under the general direction of Dr. W. T. Councilman of the auxiliary committee, was in daily attendance at the exhibition, between the hours of 10 A.M. to 12 M., 3 to 5 and 8 to 10 P.M. During each period 6 persons, one of whom acted as chief, stationed themselves in different parts of the exhibition halls, in readiness to explain exhibits and to answer questions. Each guide wore a ribbon badge.

In the course of the exhibition more than 100 persons served in this capacity. The chief guides and many of the others were physicians; their numbers were supplemented by students from the medical schools of Harvard University, Boston University and Tufts College, and by nurses of the Boston Instructive District Nurses Association and from the hospital training schools.

The persons who were to act as guides and demonstrators met at the exhibition on the evening before the formal opening, December 27, to receive general instructions and to familiarize themselves with the exhibits.

It is believed that the service of these guides greatly increased the value of the exhibition to the general public, and contributed in no small degree to its effectiveness and general success.

## VIII. Attendance.

A careful record of the number of persons entering the hall was kept throughout the exhibition. An attendant stationed near the main entrance registered each visitor as he entered, by means of a tally disc, which was read every two hours, the reading being entered upon the daily record of the exhibition.

The attendance upon the special meetings and lantern-slide demonstrations in the lecture room was estimated, the number of seats in this room being accurately known. The attendance in this lecture room is, of course, included in that recorded at the main entrance.

The following is a table showing the daily and the total attendance: —

| Date. | Day of Exhibition. | Weather Conditions. | Attendance. |
|---|---|---|---|
| Thursday, Dec. 28, 1905, | 1 | Fair, | 856 |
| Friday, Dec. 29, 1905, | 2 | Warm, cloudy, | 1,388 |
| Saturday, Dec. 30, 1905, | 3 | Clear, | 1,792 |
| Sunday, Dec. 31, 1905, | 4 | Clear, mild, | 1,902 |
| Monday, Jan. 1, 1906, | 5 | Clear, | 1,907 |
| Tuesday, Jan. 2, 1906, | 6 | Clear, | 1,830 |
| Wednesday, Jan. 3, 1906, | 7 | Clear, | 2,209 |
| Thursday, Jan. 4, 1906, | 8 | Warm, showers early, | 2,913 |
| Friday, Jan. 5, 1906, | 9 | Warm, cloudy, | 3,162 |
| Saturday, Jan. 6, 1906, | 10 | Clear, mild, | 4,154 |
| Sunday, Jan. 7, 1906, | 11 | Colder, clear, | 3,840 |
| Total, | | | 25,953 |

Period of the exhibition, 11 days of 13 hours each.
Total attendance, 25,953.
Average daily attendance, 2,359.
Total number of exhibition hours, 143.
Average attendance per hour, 181.4.

## IX. Special Meetings.

In accordance with the plan to emphasize the educational side of the exhibition, arrangements were made for a series of public meetings in the lecture room adjoining the exhibition hall, the purpose of which should be to outline clearly the various ways in which effort may be directed towards the prevention of tuberculosis and the principles underlying its treatment.

It was decided to hold meetings in the interest of physicians, employers, workingmen, clergymen and others interested in philanthropic work, tuberculosis societies, boards of health, trained nurses, the managers of public and private institutions, and teachers.

Persons qualified to represent these varied interests were invited to act as chairmen of these meetings, and to arrange for such programs and speakers as might to them seem desirable.

In addition to these meetings, arrangements were made for a formal opening meeting on the evening of the first day of the exhibition and for three public meetings on the afternoon and evening of the closing day. The first of these three was designed for Hebrews, the second for Italians, and the third, the last meeting of the exhibition, was in the interests of the public at large, and designed to sum up the general teachings of the exhibition.

Thirteen meetings were held, as follows: —

*Thursday, Dec. 28, 1905, 8 P.M.* — Formal opening of the exhibition. Dr. H. P. Walcott, chairman of the State Board of Health, presided. The Governor-elect, the Hon. Curtis Guild, Jr., was prevented by illness from attendance.

Dr. Walcott remarked upon the decline in the death rate from tuberculosis in Massachusetts during the past fifty years, stating that this diminution has been rather more than 50 per cent. After thanking the members of the auxiliary committee and others who had assisted in the work of the exhibition, Dr. Walcott introduced the following speakers: —

Dr. Alfred Worcester, Waltham. Dr. Worcester spoke of the awakening of public interest in the campaign against tuberculosis, and referred to the excellent results of the work carried on at Rutland.

Talcott Williams, Esq., Philadelphia. Mr. Williams delivered the principal address of the evening, in the course of which he referred to the increase of personal and national responsibility regarding tuberculosis, which has followed the increase of knowledge of the disease. He noted the efforts which have been made in different countries and in different parts of this country to prevent the spread of tuberculosis, and talked upon the educational value of such exhibitions as these. He laid considerable emphasis upon the importance of dust and of unhygienic conditions in tenement houses and in servants' rooms as factors in the occurrence of tuberculosis.

*Friday, December 29, 8 P.M.* — "The Employer's Opportunity." Gen. Thomas Sherwin, president of the New England Telephone and Telegraph Company, chairman.

In opening the discussion, General Sherwin said that the heads of large

mercantile, transportation and other concerns are keeping pace with the discoveries of the medical profession. "Let the physician mark out the course," he said, "and the business men will see that it is followed." General Sherwin then introduced the following speakers: —

Mr. John Graham Brooks. Mr. Brooks spoke from the standpoint of the Consumers' League. He said that those who purchase goods made in sweat shops are individually and collectively responsible for the conditions which exist in the sweat shops. "The sweat shop," he said, "is the breeding place of the bacilli of consumption." Sixty manufacturers are now using the label of the Consumers' League.

Dr. J. W. Hannum, Ludlow. Dr. Hannum spoke of the care taken of the health of its employees by the Ludlow Manufacturing Company. The houses of the workingmen are built on strictly sanitary lines, which allow light and fresh air to penetrate to every part of the structure.

Dr. J. M. Keniston, superintendent of the Hartford Hospital. Dr. Keniston said that the Hartford Hospital has an annex on Cedar Mountain, with 50 beds, for cases of incipient tuberculosis. At the main hospital two wards of 29 beds each have been set apart for advanced cases. The State appropriates $7,500 per annum towards the support of these wards. This proving inadequate, the workingmen have contributed in small amounts a sum amounting to practically $8,000, which will endow 18 free beds for one year each. Twelve thousand people contributed to this fund, and thus became virtually stockholders of the hospital, as well as missionaries in spreading the newest and best methods of preventing and treating tuberculosis. The free beds are assigned by a committee of three from each ward, after a thorough examination by the visiting physicians of the Hartford Hospital, and with the approval of an executive committee, also chosen by the workingmen.

Mr. C. H. J. Woodbury, secretary of the New England Cotton Manufacturing Association. Mr. Woodbury spoke of the importance of the care of employees by manufacturers, and described the means which have been taken by the textile manufacturers of the State to promote the physical welfare of their operatives.

Mr. William A. Hovey of the American Bell Telephone Company. Mr. Hovey spoke of what the telephone companies are doing in the interests of their employees, and emphasized the fact that if the people really want a thing they generally get it. He said that if the people of Massachusetts really desire to stamp out tuberculosis, it can be done.

*Saturday, December 30, 3 P.M.* — "The Duty of the Physician regarding Tuberculosis." Dr. Arthur T. Cabot, president of the Massachusetts Medical Society, chairman.

Dr. Cabot said that the duty of the physician in regard to tuberculosis is twofold, viz., towards the patient and towards the community. His duty towards the patient is to detect the disease as early as possible, and show how to effect a cure. His duty toward the community is to see that advanced cases of consumption are so cared for as to prevent the dissemination of

tubercle bacilli from their sputum among the public generally, and especially among those with whom the patient lives. He spoke of the increase of knowledge in regard to tuberculosis during the last twenty years, remarking that the mortality from the disease has been cut in half, and that with like progress in the next decade it might be hoped to reduce the mortality by a like amount. He then introduced the following speakers: —

Dr. Alfred Worcester, Waltham. Dr. Worcester spoke of the apathy of the public regarding advanced cases of tuberculosis, noting that in very few communities is provision made for the treatment of such, although the greatest danger of infection lies in these cases.

Dr. Vincent Y. Bowditch, Boston. Dr. Bowditch was introduced as the physician who had done more for the consumptives in this State than any other man. He was the first to demonstrate that it was not necessary to go to Colorado or other distant places to cure the disease, and that cure could be effected here. He proved this at Sharon and Rutland. Dr. Bowditch said that there is no necessity of becoming unduly alarmed over tuberculosis, and that the fact that the disease is curable and its spread preventable has been demonstrated. He stated, further, that in the course of time, after the public has become fully alive to the importance of right living, working and sleeping, the disease can be eliminated entirely.

*Sunday, December 31, 3 P.M.* — "Tuberculosis and the Workingman." Mr. John F. Tobin, general president of the Boot and Shoe Workers' Union, chairman.

Mr. Tobin spoke of the necessity of further municipal provision for the treatment of tuberculosis, and appealed to workingmen to pay greater attention to the importance of fresh air and of keeping their bed-room windows open day and night. He then introduced the following speakers: —

Mr. Henry Abrahams, secretary of the Cigarmakers' Union. Mr. Abrahams said that it was time for the city of Boston to do something towards limiting the spread of consumption, a disease which is decimating the families of workingmen. He also emphasized the importance of paying attention to the simple laws of health in the home and in the workshop.

Dr. E. A. Burnam, Boston. Dr. Burnam outlined in a popular way the nature of pulmonary tuberculosis, spoke of the symptoms, and by means of lantern slides illustrated the unsanitary conditions under which working people live, and also the present-day methods of out-door treatment of consumption.

*Monday, Jan. 1, 1906, 2 P.M.* — "The Opportunity of Philanthropy." Mr. Robert A. Woods of the South End House, Boston, chairman.

Mr. Woods, in opening the meeting, called especial attention to the opportunity of philanthropy in the campaign against tuberculosis. He said that in this warfare fresh air, sunshine and right living are the important factors. He endorsed the proposed legislation limiting the height of buildings, that might tend to keep from the people both fresh air and sunshine. He then introduced the following speakers: —

Rev. Francis X. Dolan of the Cathedral of the Holy Cross, Boston. Dr. Dolan spoke on the "Tuberculous Patient and the Clergyman." He noted the opportunity which the clergy have to come in contact with people in their homes and of noting the misery and suffering which tuberculosis may bring into the homes of the poor. He referred to the opportunity which the clergyman has, in going about among the people, of impressing upon them the importance of right living and of the observance of the simple rules of hygiene.

Rev. Ellwood Worcester of Emmanuel Church, Boston. Dr. Worcester told of the formation of the Emmanuel Church Tuberculosis Class, and of the good results which had followed the carrying out of the plans for the furtherance of which this class was organized. The work done in this class was largely educational; patients were taught how to avail themselves of roofs, balconies and even of fire-escapes in order to increase their access to the open air. Of the 25 persons who constituted this class, all but 1, in the course of the summer, gained in weight from 12 to 34 pounds.

Dr. Clarence J. Blake, Boston. Dr. Blake pointed out wherein the clergy may greatly assist the medical profession in the warfare on tuberculosis. He said that in no other field, perhaps, can their united efforts accomplish so much of positive good to the community.

*Tuesday, January 2, 3 P.M.* — "Tuberculosis Societies." Dr. Edward O. Otis, president of the Boston Association for the Relief and Control of Tuberculosis, chairman.

Dr. Otis, in opening the meeting, dwelt at some length on the social aspect of the warfare on tuberculosis through local organizations. He believed that the combined and co-ordinate efforts of such organizations are absolutely necessary, as is also the co-ordination of all philanthropic and charitable work. He spoke of the need in this country of a national society for the control of tuberculosis, similar to such as now exist abroad. He said that much of the work in the campaign against tuberculosis lies peculiarly within the province of the laymen, and that it is of prime importance that public sentiment should be aroused, and people impressed with a sense of their duty to preach the doctrine of fresh air, sunshine and right living as the sure preventives of the disease, and its only cure. He then introduced the following speakers: —

Dr. Frederick I. Knight, Boston. Dr. Knight emphasized the value of rest in the treatment of tuberculosis, and the importance of obedience to simple hygienic laws by persons inheriting a predisposition to consumption. He believed that tuberculosis societies and boards of health should pay some attention to hotels, railway stations and other places where people are obliged to mingle indiscriminately.

Archibald M. Howe, Esq., president of the Cambridge Anti-Tuberculosis Society. Mr. Howe spoke of the work of the Cambridge society, and said that he believed it to be a matter of the highest moment to Cambridge that a beginning had been made in the warfare against tuberculosis in a city in-

cluding within its limits all kinds and conditions of men, as well as a university. He said, further, that while at first he was not specially interested in the movement, he now finds it to be one of the most interesting of human causes in which to work.

Mr. ALEXANDER M. WILSON, secretary of the Boston Association for the Relief and Control of Tuberculosis. Mr. Wilson told of the work which the Boston association is doing in connection with the recording of the localities in which tuberculosis exists. He spoke of the educational nature of its work, and of the leaflets and circulars issued by the association, many thousands of which have been sent out broadcast. He also spoke of the work done in the day camp at Parker Hill, under the auspices of the association, as well as of the work which is being carried on in the homes of consumptives by physicians, nurses and visitors acting in its behalf.

*Wednesday, January 3, 3 P.M.* — "Boards of Health and their Responsibilities." Dr. SAMUEL H. DURGIN, chairman of the Boston Board of Health, chairman.

Dr. Durgin reviewed the efforts of the local health officials since 1900, when the registration of cases of tuberculosis in Boston was begun. "No large percentage of the total number of cases," he said, "reaches the records, but the percentage is rapidly growing, at least in Boston, thanks to the better education of physicians and the people generally." Dr. Durgin, by means of charts and tables, showed the variations in the death-rates of the principal diseases in Boston during the past fifty years. He then introduced the following speakers: —

Dr. C. V. CHAPIN, Providence. Dr. Chapin said that some advances had been made in Providence in the direction of locating consumptives. He urged upon health officials the importance of making boards of health "clearing houses" for cases of tuberculosis.

Mr. JAMES C. COFFEY, Worcester Board of Health. Mr. Coffey emphasized the importance of educating the people as to the modes of infection in tuberculosis and the means for the prevention of the disease.

Dr. H. LINCOLN CHASE, Brookline Board of Health. Dr. Chase spoke of the value of systematic sanitary inspection and of the importance of locating advanced cases of consumption. He explained that Brookline has already undertaken the care of advanced cases in hospitals near to the families and the friends of patients, a factor which he believes to be of much importance in the success of such institutions.

Mr. WILLIAM ATKINSON, Boston. Mr. Atkinson discussed the influence of the height and the position of buildings in determining the amount of sunlight available for their interior. He spoke of the advantages of having the diagonals of buildings in a north and south line, which favors the access of sunlight to every part of the structure. He illustrated the effect of "sky-scrapers" in shutting out sunlight, and outlined the bill to be presented to the Legislature limiting the height of buildings.

*Thursday, January 4, 7.45 P.M.* — "The Opportunity of the Trained Nurse." Dr. VINCENT Y. BOWDITCH, chairman.

Dr. Bowditch in his introductory remarks gave an account of the Sharon Sanatorium. He then introduced the following speakers: —

Dr. Henry B. Dunham, Rutland Sanatorium. Dr. Dunham spoke of the practical methods used by nurses in attending cases at different stages of the disease. He urged the importance of efforts to keep the patient cheerful, and the importance of fresh air.

Dr. Walter A. Griffin, resident physician of the Sharon Sanatorium. Dr. Griffin emphasized the importance of the work of the trained nurse in the treatment of tuberculosis, and referred to the opportunity which the nurse has, by tact and cheerfulness, to promote the peace of mind and raise the courage of her patients. "Hopefulness," he said, "is a great factor in the cure, and everything done to encourage the patient is of direct therapeutic value." He laid stress on the importance to the nurse of her care for her own health as a safeguard against infection.

Dr. J. H. Pratt, Boston. Dr. Pratt outlined the work of the Emmanuel Church Tuberculosis Class, carried on under his direction. He spoke of the value of roofs as means for giving patients in the tenement-house districts access to an abundance of fresh air.

Miss M. A. Gallagher of the Boston Instructive District Nursing Association. Miss Gallagher described the work of the association in this city, explaining how the visiting nurses are able greatly to improve the conditions in which patients in the poorer parts of the city live, and of the opportunity for giving timely advice to the families of such patients as to the means of avoiding infection.

*Friday, January 5, 3 P.M.* — "Tuberculosis in Institutions." Dr. Charles W. Page, superintendent of the Danvers Insane Hospital, chairman.

The following program was presented: —

Dr. H. C. Clapp, visiting physician, State Sanatorium, Rutland. "The importance of early diagnosis in cases of tuberculosis. Should tuberculin be used in institutions as a diagnostic measure?"

Dr. O. F. Rogers, trustee of Danvers Insane Hospital. "Should tuberculous persons be segregated in public institutions?"

Dr. E. A. Locke, visiting physician, Long Island Hospital. "In providing special wards for tuberculous patients, should regard be had to the stage of the disease?"

Dr. Wilder Tileston, visiting physician, Long Island Hospital. "The dietetic, hygienic and medical treatment of tuberculosis in public institutions."

Dr. John H. Nichols, superintendent, Tewksbury State Hospital. "What special instructions regarding tuberculosis should be given institution nurses and other employees? Are nurses caring for cases of tuberculosis in danger of contracting the disease?"

Dr. Owen Copp, executive officer, State Board of Insanity. "What should be the State policy regarding tuberculosis in insane asylums?"

Dr. J. I. McLaughlin, physician, Massachusetts State Prison. "The prevention of tuberculosis in penal institutions."

F. G. PETTIGROVE, Prison Commissioner. "Massachusetts State policy regarding tuberculosis in penal institutions."

Dr. THEOBALD SMITH, professor of comparative pathology, Harvard University. "What is the relation between human and bovine tuberculosis, and how does it affect inmates of public institutions?"

Dr. AUSTIN PETERS, Chief of Cattle Bureau. "Can tuberculosis be eradicated from the dairy stock of our public institutions?"

*Saturday, January 6, 3 P.M.* — "The Opportunity of the Teacher in the Prevention of Tuberculosis." Mr. GEORGE H. MARTIN, secretary of the State Board of Education, chairman.

Mr. Martin referred to the meeting as a step in progress toward better hygienic standards everywhere, and especially in the schools, and expressed the hope that in time it will be made unlawful to construct tall buildings where they will cut off fresh air and sunlight from a schoolhouse. He then introduced the following speakers: —

Dr. GEORGE S. C. BADGER, medical inspector in the Boston schools. Dr. Badger stated that but 10 cases of tuberculosis had been discovered among 16,000 pupils of the Boston schools examined in 1904, and that the record of 179 deaths from tuberculosis of persons from five to twenty years of age during the same year indicated that the consumptive children do not go to school. He emphasized that the mission of the teacher with regard to tuberculosis is that of prevention, and that the teacher, by instilling into the pupil sound ideas on fresh air, cleanliness and other simple hygienic matters, may accomplish much in this direction. He said that he hoped that the employment of nurses for the schools would become general.

Prof. W. T. SEDGWICK, Massachusetts Institute of Technology. Professor Sedgwick dwelt upon the opportunity which the teacher has to foster among his pupils correct ideas with regard to fresh air and good food, prime requisites in the prevention of tuberculosis.

*Sunday, January 7, 2.30 P.M.* — Meeting for Hebrews. Mr. SAMUEL H. BOROFSKY presided.

After introductory remarks Mr. Borofsky presented the following speakers, some of whom addressed the audience in Hebrew: —

Dr. Charles Rosenthal, Dr. H. Finkelstein, Rabbi Friedman, Mr. David A. Ellis, Mr. Max Mitchell, Mr. Philip Davis, Mr. Louis Gordon, Dr. Louis Mendelsohn.

*Sunday, January 7, 4.30 P.M.* — Meeting for Italians. Dr. ROCCO BRINDISI, chairman.

Dr. Brindisi addressed the audience in Italian, and then presented the following speakers, who likewise spoke in Italian: —

Baron Gustavo Tosti, Italian Consul; Dr. Tomasco Marco, Dr. Enrico A. Scalzilli.

*Sunday, January 7, 8 P.M.* — Closing meeting of the exhibition, the Hon. John F. Fitzgerald, mayor of Boston, presiding.

Mr. Fitzgerald, in his opening remarks, referred to the need of further hospital accommodations for consumptives in this city, and stated that he

would endeavor to bring about the erection of a consumptives' hospital as soon as the financial condition of the city would warrant it. He then introduced the following speakers: —

Dr. W. T. Councilman, professor of pathology at Harvard University. Dr. Councilman summarized the teachings of the exhibition, emphasizing the fact that it was primarily an educational movement, the purpose of which was to teach the general public the causes of tuberculosis and the means of prevention. He stated that the most important weapon in the campaign against tuberculosis is education, and that knowledge as to the nature of the disease must be diffused broadly throughout the masses of the people.

Rev. James O'Brien, South Boston. Dr. O'Brien made an appeal for those living in the congested tenement-house districts of the city and those who are obliged to work in sweat-shops.

Rev. S. M. Crothers, Cambridge. Dr. Crothers said that the movement for the prevention of tuberculosis is rapidly taking its place among the great social problems of the day, such as intemperance and poverty. Slum conditions, he said, cannot remain long in the face of the movement which is being directed against their continuation.

The following is a tabular list of these meetings, showing attendance: —

| Date. | Hour. | Subject. | Attendance. |
|---|---|---|---|
| Thursday, Dec. 28, 1905, | 8.00 P.M. | Formal opening, | 400 |
| Friday, Dec. 29, 1905, | 8.00 P.M. | "Employer's Opportunity," | 300 |
| Saturday, Dec. 30, 1905, | 3.00 P.M. | "Duty of Physicians," | 450 |
| Sunday, Dec. 31, 1905, | 3.00 P.M. | "Tuberculosis and the Workingman," | 400 |
| Monday, Jan. 1, 1906, | 3.00 P.M. | "Opportunity of Philanthropy," | 275 |
| Tuesday, Jan. 2, 1906, | 3.00 P.M. | "Tuberculosis Societies," | 275 |
| Wednesday, Jan. 3, 1906, | 3.00 P.M. | "Boards of Health," | 300 |
| Thursday, Jan. 4, 1906, | 7.45 P.M. | "Trained Nurses," | 750 |
| Friday, Jan. 5, 1906, | 3.00 P.M. | "Institutions," | 600 |
| Saturday, Jan. 6, 1906, | 3.00 P.M. | "Teachers," | 500 |
| Sunday, Jan. 7, 1906, | 2.30 P.M. | Hebrews, | 250 |
| Sunday, Jan. 7, 1906, | 4.30 P.M. | Italians, | 175 |
| Sunday, Jan. 7, 1906, | 8.00 P.M. | Closing meeting, | 600 |
| Total, | | | 5,275 |

## X. Lantern-slide Demonstrations.

In furtherance of the educational purpose of the exhibition, lantern-slide demonstrations were given in the lecture room on seven evenings at 8.30. A new and efficient stereopticon lantern, adapted for use with the arc light, and provided with a reflectoscope, was obtained for a nominal rental fee and installed in the lecture room for use throughout the exhibition. This

lantern was operated by one of the paid assistants, and was a source of practically no extra expense. The slides were provided by the demonstrators.

Demonstrations were given as follows: —

*Saturday, Dec. 30, 1905.* — Dr. W. T. COUNCILMAN, "The Nature of Tuberculosis." Dr. Councilman showed photomicrographs of the tubercle bacillus and of the lesions which it produces in the tissues. In the course of his demonstration he explained the ordinary mode of infection, and outlined the course of the disease as it progresses, or as it declines under conditions favorable to cure.

*Sunday, December 31.* — Dr. JOSEPH H. PRATT, "The Treatment of Tuberculosis." Dr. Pratt demonstrated some of the possibilities in the out-door treatment of tuberculosis. By means of photographs and charts he explained the methods followed by the Emmanuel Church Tuberculosis Class, in which, under his direction, 25 consumptives were successfully treated in their own homes.

*Monday, Jan. 1, 1906.* — Dr. E. H. BRADFORD, "Tuberculosis in Children." Dr. Bradford described in a general way the treatment of bone tuberculosis, which is common in children, and which he says is as curable as pneumonia. By means of photographs he illustrated the fresh-air treatment of cases of this sort as practised at the Convalescent Home of the Children's Hospital at Wellesley.

*Tuesday, January 2.* — Dr. H. C. ERNST, "The Bacteriology of Tuberculosis." Dr. Ernst described modes of infection, and emphasized the importance of the sputum of consumptives as a means of spreading contagion. He demonstrated by photographs of cultures and photomicrographs of the bacteria the characteristics of the various races of tubercle bacilli, and sketched the development of the lesions in the lung which result from the lodgment and growth of inhaled organisms.

*Wednesday, January 3.* — Dr. E. O. OTIS, "The Treatment of Tuberculosis." The demonstration consisted of numerous photographs illustrating methods of treatment now employed in hospitals and sanatoria in different parts of the country.

*Friday, January 5.* — Dr. T. LEARY, "The Pathology of Tuberculosis." The demonstration was preceded by a brief address by Dr. Livingston Farrand, executive secretary of the National Association for the Study and Prevention of Tuberculosis (introduced by the assistant to the secretary). Dr. Farrand spoke chiefly of the economic aspects of tuberculosis, stating that "the disease causes annually in the United States from 150,000 to 200,000 deaths, 10,000 of which occur in New York City alone. In dollars and cents this means $33,000,000 in New York lost annually by the community, and in the country probably $330,000,000." Dr. Farrand spoke also of the educational value of the exhibition, and stated that it would be sent in succession to many of the larger cities of the country.

Dr. Leary, by means of the reflectoscope, projected colored drawings and plates illustrative of the pathological anatomy and histology of the lung in tuberculosis, explaining in untechnical language the changes which

the lungs undergo in the progress of the disease from the earlier to the more advanced stages.

*Saturday, January 6.* — Dr. A. C. GETCHELL, "The Rutland Sanatorium." Dr. Getchell showed photographs of the buildings, grounds and general surroundings of the State Sanatorium, together with others illustrative of the methods of treatment employed there.

The following is a table showing the attendance at the lantern-slide demonstrations: —

| DATE. | Demonstrator. | Attendance. |
|---|---|---|
| Saturday, Dec. 30, 1905, | Dr. W. T. Councilman, | 275 |
| Sunday, Dec. 31, 1905, | Dr. J. H. Pratt, | 250 |
| Monday, Jan. 1, 1906, | Dr. E. H. Bradford, | 325 |
| Tuesday, Jan. 2, 1906, | Dr. H. C. Ernst, | 350 |
| Wednesday, Jan. 3, 1906, | Dr. E. O. Otis, | 475 |
| Friday, Jan. 5, 1906, | Dr. T. Leary, | 500 |
| Saturday, Jan. 6, 1906, | Dr. A. C. Getchell, | 450 |
| Total, |  | 2,625 |

## XI. EXPENSE.

The following schedule presents a classified statement of the expenses of the exhibition: —

| | | |
|---|---|---|
| *A.* Exhibition proper: — | | |
| 1. Rent of hall, | $800 00 | |
| 2. Equipment of hall, | 280 65 | |
| 3. Paid assistants, | 207 90 | |
| 4. Transportation, freight, etc., | 86 21 | |
| 5. Sign painting, | 103 70 | |
| 6. Police, | 30 00 | |
| 7. Miscellaneous, | 32 59 | |
| | | $1,541 05 |
| *B.* Publicity: — | | |
| 1. Stationery and postage, | $334 30 | |
| 2. Printing, | 209 50 | |
| 3. Clerk hire (mailing), | 138 75 | |
| 4. Advertising (Boston Elevated Railway), | 80 00 | |
| | | 762 55 |
| *C.* Exhibit of State Board of Health: — | | |
| 1. Photographs, | $119 00 | |
| 2. Charts, | 52 50 | |
| 3. Frames, framing and lettering, | 31 36 | |
| 4. Circular letters, | 40 91 | |
| | | 243 77 |
| *D.* Travelling expenses, | | 69 60 |
| | | $2,616 97 |

This total expense of $2,616.97, deducting the cost of the exhibit of the State Board of Health, becomes $2,373.20, which is the real cost of installing, advertising and maintaining the exhibition.

The exhibition held in New York City November last, under the joint auspices of the Charity Organization Society and the National Association for the Study and Prevention of Tuberculosis, in the matter of exhibits was nearly identical with the Massachusetts exhibition.

The New York societies who managed the exhibition were given the free use of one of the halls of the American Museum of Natural History, and consequently paid no rent. Notwithstanding this, the New York exhibition cost approximately $2,000, this expense, according to competent authority, being distributed as follows: —

| | |
|---|---|
| Equipment of hall, | $500 00 |
| Printing, | 400 00 |
| Attendants, | 200 00 |
| Postage, | 100 00 |
| Miscellaneous, | 800 00 |
| Total, | $2,000 00 |

The plans for the Massachusetts exhibition were drawn up and the means for securing publicity arranged for at a time when it was expected that Faneuil Hall would be used as an exhibition place. The rent of this hall would have amounted to $300. The excess of expense over the appropriation was inevitable when, by the engaging of Horticultural Hall, the item of rent was increased by the sum of $500.

## XII. General Remarks.

The purpose of this exhibition was essentially to present to the people of the Commonwealth a clear explanation of the methods now in use for the treatment of tuberculosis, and of the means whereby the disease may be prevented.

It is believed that this purpose was fulfilled to a satisfactory degree.

The exhibits assembled in the exhibition were numerous, representative and instructive. They set forth effectively the fundamental facts concerning the nature of tuberculosis, its modes of spread, and the conditions favorable and unfavorable to its prevalence. They showed as clearly as photographs and models of buildings and tents can illustrate the manner in which consumptives are treated in the best hospitals and sanatoria of the day, both in this country and abroad, and they bore witness to the good results consequent upon such treatment. They demonstrated the possibilities in connection with home treatment of the disease, and pointed out the effective use which may be made of the roof, the piazza and even of the fire-escape platform, by the patient who has learned that his recovery depends mainly upon his being in the open air. Certain of the exhibits set forth the methods employed in the larger cities of the country for the education of the community regarding the infectious nature of tuberculosis, and the means whereby the consumptive may avoid spreading contagion, and those about him may escape infection.

The plan to supplement the exhibition proper by addresses and demon-

strations designed to emphasize the principles set forth by the exhibits seemed to be wholly justified by the general interest taken in the meetings, and the high educational value which these undoubtedly possessed. Seven thousand nine hundred persons, or nearly one-third of all those who attended the exhibition, were present at the meetings in the lecture room; and, in view of the excellence of the service rendered by the speakers and demonstrators, it is probable that much good was accomplished by this means.

The attendance at the exhibition was satisfactorily large and representative. It is certain that among the visitors were many persons from out of town, including some from cities and towns in the interior of the State. The rate of attendance increased daily until practically the close of the exhibition. The aggregate attendance exceeded by 9,000 that of a similar exhibition held in New York City during a somewhat longer period (two weeks).

The choice of Horticultural Hall as a place for the exhibition necessitated an expense for rent greater by $500 than would have been contingent upon the use of Faneuil Hall. The latter place, although desirable from location and low cost, from its relatively small size would have proved wholly inadequate for the proper display of all of the exhibits, and would have prohibited the special meetings and demonstrations.

It is believed that this exhibition has enlightened the people of the Commonwealth regarding tuberculosis; that it has demonstrated the only methods of successful treatment; and that by diffusing knowledge the exhibition has directed attention to the various means whereby the disease may be prevented.

## Recommendations concerning Pest Houses, and Laws relating thereto.

The Legislature of 1905 passed a resolve relative to a revision of the laws relating to the establishment of pest houses by cities and towns; and the Board reported, in accordance therewith, on Jan. 15, 1906, as follows: —

The Legislature of 1905 passed the following resolve: —

### Resolve relative to a Revision of the Laws relating to the Establishment of Pest Houses by Cities and Towns.

*Resolved,* That the state board of health is hereby directed to investigate the advisability of revising the laws relative to the establishment and maintenance of pest houses by cities and towns, and to report thereon to the next general court not later than the fifteenth day of January, nineteen hundred and six. [*Approved April 28, 1905.*

In accordance with this order, the State Board of Health has made a careful study of such reports as were at hand or could be obtained concerning the relation of hospitals for contagious diseases to the health of

inhabitants of neighboring areas; but it has been unable to find any evidence which would lead it to recommend any radical changes in the laws referred to, except the addition of a provision to enable cities and towns, in certain cases, to establish and maintain such hospitals in common.

The Board takes this opportunity, however, of calling to the attention of the Legislature the fact that in the laws as they now stand there exist certain phrases that are not sufficiently explicit, and certain provisions which are redundant.

That portion of chapter 75 of the Revised Laws which relates to hospitals and dangerous diseases consists of sections which have been passed in different years, and amended as occasion has demanded; and, in consequence, there is lacking to some extent the logical sequence which should and easily can obtain. The Board would therefore recommend the following changes in chapter 75 of the Revised Laws and in chapter 206 of the Acts of 1902: —

### Chapter 75, Revised Laws.

1. Striking out in the fourth line of section 35 the words "or of a committee of the town appointed for the purpose."

2. Amending section 42 by inserting after the word "board," in the third line, the words "of health;" and before the word "board," wherever else it occurs in this section, the word "said;" and causing this section, so amended, to become section 36.

3. Amending section 40 by adding the following: "*provided, however,* that if, in the opinion of the boards of health of two or more adjoining cities or towns, such hospitals can advantageously be established and maintained in common, the authorities of the said cities or towns may enter into such agreements as may be necessary for the establishment and maintenance of the same;" and causing section 40, so amended, to become section 37.

4. Amending section 36 by striking out the words "or committee," in the fourth line, and causing it to become section 38.

5. Amending section 37 by striking out the words "without the consent of said towns," in the third line, and substituting therefor the words "or city without the consent of the board of health of said town or city;" and causing the section, thus amended, to become section 39.

6. Causing section 38 to become section 40.

7. Causing section 39 to become section 41.

8. Causing section 41 to become section 42.

9. Amending section 46, as amended by chapter 206 of the Acts of 1902, by inserting after the word "board," in the fourth line, the words "of health."

10. Amending section 56 by striking out in the first and second lines the words "sections forty-two, forty-three and forty-four," and substituting therefor the words "sections thirty-six and forty-six."

CHAPTER 206, ACTS OF 1902.

11. Amending section 1 of chapter 206 of the Acts of 1902 by striking out the concluding words, "provided the approval of the board of health of the city or town into which such persons are to be taken shall first have been obtained."

In the form suggested, the law would then read as follows:—

CHAPTER 75, REVISED LAWS.

. . . . . . . . . . . . .

SECTION 35. A town may establish hospitals within its limits for the treatment of diseases which are dangerous to the public health. They shall be subject to the orders and regulations of the board of health.

SECTION 36. If a disease which is dangerous to the public health breaks out in a town, or if a person is infected or lately has been infected with such disease, the board of health shall immediately provide such hospital or place of reception, and such nurses and other assistance and necessaries, as is judged best for his accommodation and for the safety of the inhabitants, which shall be subject to the regulations of the said board. The said board may cause any sick or infected person to be removed thereto, if it can be done without danger to his health; otherwise the house or place in which he remains shall be considered as a hospital, and all persons residing in or in any way connected therewith shall be subject to the regulations of the said board, and, if necessary, persons in the neighborhood may be removed.

SECTION 37. Each city shall establish and be constantly provided, within its limits, with one or more isolation hospitals for the reception of persons having smallpox or any other disease dangerous to the public health. Such hospitals shall be subject to the orders and regulations of the boards of health of the cities in which they are respectively situated. A city which, upon request of the state board of health, refuses or neglects to comply with the provisions of this section, shall forfeit not more than five hundred dollars for each refusal or neglect: *provided, however,* that if, in the opinion of the boards of health of two or more adjoining cities or towns, such hospitals can advantageously be established and maintained in common, the authorities of the said cities or towns may enter into such agreements as may be necessary for the establishment and maintenance of the same.

SECTION 38. The physician, nurses, attendants, patients and all persons approaching or coming within the limits of such hospitals, and all furniture and other articles used or brought there, shall be subject to the regulations of the local board of health.

SECTION 39. Such hospitals shall not be established within one hundred rods of an inhabited dwelling house situated in an adjoining town or city without the consent of the board of health of said town or city.

SECTION 40. Whoever occupies or uses a building for a hospital in a part of a city or town prohibited by the mayor and aldermen or selectmen shall forfeit not more than fifty dollars for every month during which such offence continues, and in like proportion for a portion of the month. The supreme judicial court or the superior court shall have jurisdiction in equity to restrain such occupancy or use.

SECTION 41. Each city shall provide for the treatment, either in a hospital or as out-patients, of indigent persons who are suffering from contagious or infectious venereal diseases.

SECTION 42. No discrimination shall be made against the treatment of venereal diseases in the out-patient department of any general hospital supported by taxation in any city in which special hospitals, other than hospitals connected with penal institutions, are not provided for the treatment of such diseases at public expense; but said hospital may establish a separate ward for their treatment.

[Sections 43, 44 and 45 remain unchanged.]

SECTION 46. A magistrate authorized to issue warrants in criminal cases may issue a warrant directed to the sheriff of the county or his deputy, or to any constable or police officer, requiring them, under the direction of the board of health, to remove any person who is infected with contagious disease, or to impress and take up convenient houses, lodging, nurses, attendants and other necessaries. The removal authorized by this section may be made to any hospital in an adjoining city or town established for the reception of persons having smallpox or other disease dangerous to the public health, provided the assent of the board of health of the city or town to which such removal is to be made shall first have been obtained.

. . . . . . . . . . . . .

SECTION 56. The provisions of sections thirty-six and forty-six, so far as they confer authority for the removal of patients from their homes, shall apply only in cases of persons residing in boarding houses, or hotels, or in cases of two or more families occupying the same dwelling, or in other cases in which, in the opinion of the board and the attending physician, the case cannot be properly isolated.

. . . . . . . . . . . . .

CHAPTER 206, ACTS OF 1902.

SECTION 1. The board of health of any city or town which has established or which may hereafter establish within its limits a hospital for the reception of persons having smallpox or any other disease dangerous to the public health, may receive for care and treatment in such hospital persons from an adjoining town who are infected with any of said diseases.

## INVESTIGATION OF FACTORIES AND WORKSHOPS.

The Legislature of 1905 passed the following resolve, directing the Board to continue its investigation of the sanitary condition of factories, workshops and other establishments where persons are employed, as follows: —

CHAPTER 59, RESOLVES OF 1905.

RESOLVE TO PROVIDE FOR CONTINUING THE INVESTIGATION BY THE STATE BOARD OF HEALTH OF CONDITIONS AFFECTING THE HEALTH OR SAFETY OF EMPLOYEES IN FACTORIES AND OTHER ESTABLISHMENTS.

*Resolved,* That the state board of health, with such aid as it may require from the chief of the district police and from the bureau of statistics of labor, is hereby directed to continue the investigation of conditions affecting the health or safety of employees in factories, workshops, and other places

of employment in the Commonwealth, the said investigation having been authorized by chapter ninety-nine of the resolves of the year nineteen hundred and four. For this purpose the officers and employees of the said board shall have power to enter and inspect all premises in use for industrial purposes, and to obtain such information as may be necessary to carry out the purposes of this resolve. The board is also directed to report to the general court on or before January fifteenth in the year nineteen hundred and seven, such recommendations as it may deem expedient for the revision of the laws in this Commonwealth relating to the health, safety or welfare of persons engaged in industrial pursuits. For the above purposes the board may expend a sum not exceeding twenty-five hundred dollars during the fiscal year nineteen hundred and five, and twenty-five hundred dollars during the fiscal year nineteen hundred and six. [*Approved April 28, 1905.*

This work has been duly performed, and the following report thereon is herewith submitted: —

By chapter 59 of the Resolves of 1905, the State Board of Health was directed to continue the investigation of conditions affecting the health or safety of employees in factories, workshops and other places of employment in the Commonwealth which had been begun under authority of chapter 99 of the Resolves of 1904, the results of which were transmitted to the Legislature of 1905, and may be found in the thirty-sixth annual report of the State Board of Health, pages xxii–xxxi.

The industries reported upon at that time included cutlery grinding, stone cutting and stone polishing, cigar making, boot and shoe making, rag sorting, the rubber industry and the lead industry. Nearly all of these industries were regarded as being among those most dangerous to the health of those working in them, but even here it was found that one at least, and sometimes many establishments in each industry were carried on with satisfactory regard for the health of the working people.

This condition led this Board to recognize that the most efficient and just method of improving the conditions of the working people in each one of these industries would be to require those proprietors who carry on their work with little provision for the health of their employees to make such provision as is made by those who provide the best. This is the most practicable method of accomplishing the putting of the whole business upon a fairer basis, and of encouraging those employers best disposed to improve still further the conditions regarding the health of all employed.

This recognition caused the Board to recommend "that it be the duty of the inspection department of the district police to require, so far as is reasonably practicable under the varying circumstances, as efficient protection to the health of the operatives in any occupation as is pro-

vided in that occupation where, within the Commonwealth, such protection is most efficient."

During the past two years further observations have been made upon the industries previously examined, together with the following: —

Manufacture of agricultural implements, bluing, bone black, brushes, carpet yarns, carpets and rugs, celluloid goods, chairs, chemicals of various kinds, colors and mordants, electrical apparatus, emery and corundum wheels, facing, felt cloth, felt hats, files, firearms, glue, horn goods, jewelry, lampblack, lead pipe and plumbers' supplies, leather, lithographs, machinery, mouldings and frames, optical goods, pearl buttons, pianos, pottery, sandpaper, shoddy, soap, stains and blackings, stoves, stove polish, straw hats, textiles, tools, varnishes, watches, whips, whiting, wire and wire cloth; bakeries, bleaching and dyeing, dyeing and cleansing, galvanizing, glass grinding, iron, steel and brass founding, laundries, rendering and slaughtering.

The conditions affecting the health and welfare of the working people in these industries are recorded in the Supplement. In many the conditions were found to be satisfactory. In the emery and corundum, sandpaper and certain other industries more attention should be given to keeping the dust away from the mouth and nostrils of the workmen. In the rag dusting, sorting and cutting rooms of some paper mills very objectionable amounts of dust were found, with some pale and sickly appearing operatives; but there are mills using the same kind of stock where the dust is kept away from the employees in a satisfactory manner, and much improvement is practicable in the former class. In the manufacture of shoddy and the manufactures from jute and hemp there are processes which are exceedingly dusty, requiring much improvement in the poorly managed establishments.

Machine shops are generally found in fair and some of them in very good condition. The departments connected with foundries, including casting, scaling, cleaning and smoothing, grinding and polishing, involve exposure to extreme heat, fumes and dust, which may be very injurious to the workmen. The degree in which the workmen are protected varies greatly in the different establishments; but there are many where the protection is very satisfactory, and it is desirable that others be brought up to their condition.

The cutlery and tool industry is one of the most dangerous of trades, but there are enough establishments in which the grinding and polishing machines are provided with hoods and exhaust fans to show that the danger to health may be greatly relieved; but even when so provided many workmen recklessly remove the hoods, and expose themselves to the great danger of breathing the dust made up of fine particles of steel

and of the grinder. It is possible that improvements may be made in the apparatus for removing dust that will make them more attractive to the workmen. That they do not take every means to protect themselves indicates that they do not appreciate the shortness of the lives of those who enter this industry, and that there are two or three times as many deaths, proportionately, among grinders, polishers and cutlers, due to diseases of the lungs, as among other male adults in the same community.

In cigar making we find some establishments carried on in a satisfactory manner, with good light, good ventilation and no spitting; but there are many where these conditions are far from satisfactory, and they need to be brought up to those of the better class. Too large a percentage of the operatives look pale and sickly.

In the rubber factories examined during this investigation the greater part were in better condition than those previously reported upon; and in this, as in other industries examined, those allowing poor conditions affecting the health of the operatives should be brought up to the conditions found in the better class.

In many of the smaller industries conditions requiring improvement are noted in the Supplement, and are not repeated here. The dangers accompanying the use of wood alcohol are not enlarged upon, because the removal of the tax on denatured grain alcohol is expected to prevent the further use of wood alcohol.

*The Boot and Shoe Industry.* — The great number of people employed in the boot and shoe industry in this State, and the great difference found in the care devoted to the health of the employees in different establishments, warranted a much more complete examination than has previously been made, the details of which are presented in the Supplement.

In this examination 373 establishments were visited, of which 62 were found to be with good conditions regarding the health and welfare of the working people, 220 with fair general conditions, 72 with poor conditions, and 19 with distinctly bad conditions. Of those whose general conditions are called fair, some parts were in good condition; but there were conditions in some rooms and places which distinguished them from those having general good conditions, such as poor ventilation, or water-closets not commendable.

While there are, among the older small establishments and the more modern and large establishments, many which well may be regarded as standards of excellence, there are common to this industry four conditions which can be and ought to be remedied. These are: poor ventilation, inadequate removal of dust from machines; the condition of water-closets; and spit upon the floors.

In the majority of factories visited the ventilation was found to be poor, and in many of these distinctly bad. Of the rooms not especially dusty, 102 were badly ventilated and 26 were overcrowded. In the rooms in which large amounts of dust are evolved, the number of machines with means for efficient or fairly efficient removal of dust was found to be 1,630; the number either inefficiently equipped or devoid of equipment was 2,769.

Of 84 of the many dusty rooms reported, 40 were also overcrowded, 35 were dark, 21 were overheated, and 18 were overcrowded, dark and overheated. In more than one-third of the factories visited the conditions of water-closets were not commendable; most of them were dark and dirty to very dirty. In 50 establishments no spitting was noticed, in 173 there was some, in 115 considerable and in 35 much.

In some establishments lunch rooms are provided, where the employees may eat the luncheon they have brought, or may buy one; in much the larger number the employees eat in the workrooms.

In the opinion of our inspectors, the health of the employees in this industry in the larger number of establishments appears to be fair to good; but in 85 factories, or 23 per cent. of those visited, a considerable proportion of the employees are noticeably pale and unhealthy.

In the boot and shoe industry, as in most other industries in the State, we find a class of establishments in which satisfactory provision is made for the welfare of the employees, and methods adopted for carrying on business by which their welfare is promoted. At the other end of the scale there is a minority — not large, yet altogether too large — where the conditions injuriously affecting the health of the operatives appear to have no consideration, are contrary to the intent of the laws governing factories, and are such as the better class show to be unnecessary in carrying on this business.

These unjustifiable differences urge us to recommend that laws be made to require that the conditions affecting the health of the working people in these poorly managed establishments be brought up to conditions existing in the class of establishments doing similar work in similar buildings where their health is most carefully protected; and that it be the duty of the inspectors of factories to see that the laws to bring this about are enforced.

*The Textile Industry.* — During the past year the Board has made careful investigation into the conditions affecting the health, safety and welfare of persons engaged in the great textile industry of the State, the details of which inquiries are contained in the Supplement.

In this industry we find, in establishments employing much more than

half of the total number engaged therein, that the conditions regarding the health, safety and welfare of the employees are good; and in about one-third of this number they are excellent. On the other hand, we find establishments containing a large minority of operatives where the conditions are moderately bad; and perhaps in one-third as many as we regard good are conditions which are decidedly bad.

The problem before us is to have the conditions affecting this minority raised to those which we find to be good; and we have confidence that in the bringing about of this improvement the good conditions will be made even better.

The resolve under which the foregoing investigations were made also directs this Board to report to the General Court on or before Jan. 15, 1907, such recommendations as it may deem expedient for the revision of the laws in this Commonwealth relating to the health, safety or welfare of persons engaged in industrial pursuits.

These laws are found to contain requirements upon nearly all of the conditions desired, but they are often in such form that no officer can enforce them unless he has support from something more than the mere statement of the law; for example, all would agree that cleanliness in a factory is a necessary condition relating to the health of operatives; and we have in the Revised Laws two references in substantially the same words, viz.: "All factories shall be kept clean." What is clean in an axe-grinding factory would not be clean in a silk mill; but the law makes no distinction, and the judgment of the officer cannot be received as law. In prosecuting an offender, he would have no backing in the law unless it should be some extremely bad case, in which he could satisfy the court that it was a nuisance; but such a course would have no effect in enabling him to hold factories up to the standard of cleanliness that is desirable for the health of the operatives; and we conceive it impossible to specify in any law a standard of cleanliness applicable to all industries. This being the case, and happily finding, in nearly all of the industries which we have examined, some examples of establishments where reasonable conditions of cleanliness are maintained, we should advise making it of the law that the officer should be authorized to hold all factories in any industry up to the standard of cleanliness which he finds maintained in the factories in that same industry and using the same grade of stock, which are the cleanest.

This might not be acceptable to a manufacturer who was not permitted to examine the mills of his competitors, to which the officer has access. To settle any question that might arise as to the requirements of the officer and the comparative condition of the mill in question, and

the standard above set forth, an appeal might be made by either party to the State Board of Health, authorized to examine such factories in the interests of health and to make a final settlement of such questions.

Other conditions, such as proper provision for preventing the entrance of dust into the air of the room, proper means of ventilation, proper provision for regulating light, heat and moisture, could be referred to similar standards, — standards not necessarily of methods, but of resulting conditions, which those interested to keep their operatives in the best condition of health, and consequently the most efficient, have found to be practicable.

The subjects of importance which are not mentioned in the laws regarding factories are the regulation of light, and spitting.

It might be expected that a manufacturer regarding only his own interests would keep the windows of his factory clean and the walls and ceiling of the room whitened, that he might have upon his work the best natural light; but we have found some factories where these things were neglected, and the operatives were straining their eyes trying to accomplish the work required of them. In some there was a period in the afternoon when daylight was too dim, and the turning on of artificial light was delayed, to the injury of the eyes of the operatives and probably to the injury of the work done.

It is well known that a large percentage of deaths among people whose working days are spent within the walls of industrial establishments is due to consumption. While this may be quite as much due to the conditions existing at the homes of the working people as to those existing at their working place, it is eminently unjust to those who maintain their homes in order and do everything needful to prevent the occupants from contracting consumption, that they should be obliged to seek employment in factories where the most potent means of spreading consumption are allowed to exist.

No one can spend his or her working days in a room where others, in incipient stages of consumption, habitually spit upon the floor, without the gravest danger of acquiring the disease. Such incipient cases are not always easy of detection; and the only safe protection is to prevent all spitting upon the floor or elsewhere, where the sputum on drying will be disseminated as dust through the air of the room. Experience in some factories shows this prevention to be practicable.

The modifications in the laws relating to the health, safety or welfare of persons engaged in industrial pursuits are the following; but, as the enforcement of these laws depends in general upon members of the inspection department of the District Police, it is essential that this department be composed of broad-minded men, who have the welfare of

the working people at heart, and have the ability to study out the requirements in any factory for their welfare, and how these can be accomplished consistent with the standards which they are to follow; and, further, are able to act justly and with tact with the employers.

*Amendments and Additions recommended.*

Chapter 104 of the Revised Laws, section 25, in regard to fire escapes, add to the clause in lines 19 and 20 so that it shall read: —

The egresses and means of escape shall be kept unobstructed, in good repair and ready for use, and shall be provided with a sign within the building that will plainly indicate their position to a person thirty feet distant.

In section 41 the last clause to be modified to read: —

All factories and workshops shall be well lighted, well ventilated and kept clean.

Following which add: —

No person shall expectorate or spit upon the floor, stairways or walls of any factory or workshop.

Chapter 108 of the Revised Laws, section 8, beginning with the end of the seventh line, and including the eighth and ninth lines, amend to read: —

the lighting and the ventilation of factories or workshops and the keeping of them clean, and the securing of proper sanitary provision therein, and the making of clothing in unsanitary conditions.

Also insert in thirteenth line, after "sanitary provisions," the words "the lighting."

And to this section (8), which puts the responsibility of enforcing the laws which have been considered upon the members of the inspection department of the District Police, add the following: —

When determining whether the conditions affecting the health, safety or welfare of the working people in any factory or workshop are in accordance with the law, and the law does not specify the standard of such conditions, said inspectors are to use as standards the conditions which they find existing in those factories and workshops carrying on similar business in similar buildings within the Commonwealth, where the health, safety and welfare of the working people are most completely protected.

Should questions arise in regard to such standards, between the said inspection department and the person carrying on such factory or workshop, said questions may be referred in writing, by either of the parties, to the state board of health, which board is hereby authorized to investigate and decide said questions, and the decision of said board shall be final.

## Investigation of the Sanitary Condition of Barber Shops.

The Legislature of 1906 passed the following resolve, providing for an investigation of the sanitary condition of barber shops: —

### Chapter 96, Resolves of 1906.

### Resolve to provide for an Investigation of the Sanitary Condition of Barber Shops.

*Resolved,* That the state board of health is hereby instructed to make an investigation, at an expense not exceeding five hundred dollars, as to the condition of barber shops in the Commonwealth, and to consider what legislation, if any, for the licensing of barbers, and for regulating or supervising their business, is necessary or desirable for the protection of the public health; and that said board report to the general court on or before the second Wednesday in January, nineteen hundred and seven, the result of its investigation, together with such recommendations for legislation as the board may deem advisable. [*Approved June 7, 1906.*

The report called for follows: —

In accordance with the provisions of this resolution, the State Board of Health has caused an investigation to be made of barber shops in the cities of the Commonwealth, to the number of more than thirteen hundred.

The inquiry was directed to the obtaining of data relative to the general sanitary conditions prevalent in barber shops, and to the technical procedures employed by barbers in the practice of their trade.

The following points were taken into consideration in the examination of each shop: —

1. General cleanliness of the premises.
2. Personal cleanliness of attendants.
3. Plumbing, including the condition of bowls or sinks, and provisions for running water.
4. Provisions for cleanliness in the technical procedures of the barber, including the use of: —

(*a*) Razors, shaving mugs and shaving brushes.

(*b*) Towels.

(*c*) Styptics.

Each shop so inspected was graded upon the basis of a detailed report as to its condition.

In establishing a standard of excellence, regard was had to the conditions

and practices favorable and unfavorable to the spread of communicable diseases through the medium of the barber's instruments or practices. The type of barber shop in which the transfer of communicable skin diseases from one person to another is least likely to occur is that in which the premises and attendants are clean, and in which the procedures incidental to shaving are accompanied by precautions against the transfer of bacteria or other disease-producing organisms from person to person. These include the disinfection of the razors and other utensils employed in shaving, prior to their use upon each customer; the use upon each customer of separate and clean towels; the rejection of such possible vehicles of contagion as powder puffs, sponges and stick caustic; and the washing of his hands by the barber before attending a customer.

With this type as a standard, five grades or classes of shops were arbitrarily established, designated, in the order of their excellence, by the letters *A, B, C, D* and *E*. According to the degree of its approximation to this standard, each shop examined was assigned a grade.

The significance of this grading is set forth by the following specimen reports, each of which is typical of the grade which it represents: —

GRADE A. No. .

*General Cleanliness.* — Floor and cuspidors clean; mantel towels and combs clean. Soiled towels disposed of by chute into basement. Shaving paper (used) in jar on floor. Towels on head rests and arms of chairs clean.

*Personal Cleanliness.* — Four barbers present, in clean white coats; did not wash hands between customers.

*Plumbing.* — Seven sinks, all clean, with good joints; running hot and cold water.

*Disinfection.* — Shaving mug rinsed out with boiling water; razor held in boiling water before using and after stropping.

*Styptics.* — Powdered alum used on towel.

*Towels.* — Clean towels on shelves in front of chairs.

GRADE B. No. .

*General Cleanliness.* — Floor and cuspidor fairly clean; mantel towels and combs fairly clean. Soiled towels put in can under mantel. Shaving paper (used) in same can with towels. Clean towels put on head rest between customers. Linoleum mats for mugs.

*Personal Cleanliness.* — Two barbers present, in clean white coats; hands not washed between customers.

*Plumbing.* — Sink rather dirty about joint; running hot and cold water.

*Disinfection.* — Shaving mug rinsed out; razor not sterilized before use.

*Styptics.* — Alum water used on finger.

*Towels.* — Clean towels piled on mantel.

GRADE C. No. .

*General Cleanliness.* — Floor fairly clean; cuspidor dirty; combs somewhat dirty; mantel towels soiled. Soiled towels put in jars on floor under mantels. Shaving paper (used) in jars on mantels. Soiled towels on backs of chairs.

*Personal Cleanliness.* — Three barbers present, in fairly clean coats; hands not washed between customers.

*Plumbing.* — One sink, cracked, with badly fitting joints; running hot and cold water.

*Disinfection.* — Implements not sterilized before use.

*Styptics.* — Stick caustic.

*Towels.* — Clean towels piled on mantels.

GRADE D. No. .

*General Cleanliness.* — Floor dirty; cuspidor fairly clean; marble mantel somewhat dirty. Soiled towels hung on line in back of room. Shaving paper (used) in jars on mantels alongside of piles of clean towels. Soiled towels on arms and backs of chairs.

*Personal Cleanliness.* — Two barbers present, in ordinary clothes.

*Plumbing.* — No running water; one sink, dirty, with bad joint; no sewer connection; waste water caught in bucket under sink.

*Disinfection.* — None.

*Styptics.* — Stick caustic.

*Towels.* — Stack of clean towels on mantel.

GRADE E. No. .

*General Cleanliness.* — Floor very dirty; cuspidor very dirty; mantel dirty; combs very dirty. Dirty towels on chairs and mantel; dirty towels in basket on floor under mantel.

*Personal Cleanliness.* — One barber present, in very dirty coat.

*Plumbing.* — One sink, filthy, with bad joint; running hot and cold water.

*Disinfection.* — None.

*Styptics.* — Powdered alum.

*Towels.* — Soiled towels folded and stacked on mantel; uniformly dirty, showing repeated use.

These specimen reports illustrate the basis upon which the shops were graded. Of necessity the individual grades or classes have a fairly wide range, and each may include shops differing greatly in particular characteristics, but which nevertheless present such combinations of conditions as to cause them to rank among the excellent, the average or the poor.

The following table sets forth the results of this classification. Shops were inspected in 32 cities and 1 town, the total number examined being 1,368.

| PLACE. | Grade A. | | Grade B. | | Grade C. | | Grade D. | | Grade E. | | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Per Cent. | No. | Per Cent. | No. | Per Cent. | No. | Per Cent. | No. | Per Cent. | |
| Beverly, | - | - | 2 | 13.4 | 13 | 86.6 | - | - | - | - | 15 |
| Boston, | 12 | 4.1 | 98 | 33.5 | 178 | 60.9 | 4 | 1.5 | - | - | 292 |
| Brockton, | - | - | 4 | 8.2 | 44 | 89.8 | 1 | 2.0 | - | - | 49 |
| Brookline, | - | - | 5 | 100.0 | - | - | - | - | - | - | 5 |
| Cambridge, | - | - | 16 | 32.0 | 34 | 68.0 | - | - | - | - | 50 |
| Chelsea, | - | - | 3 | 7.5 | 33 | 82.5 | 4 | 10.0 | - | - | 40 |
| Chicopee, | - | - | 2 | 14.3 | 12 | 85.7 | - | - | - | - | 14 |
| Fall River, | - | - | 2 | 2.8 | 60 | 83.3 | 9 | 12.5 | 1 | 1.4 | 72 |
| Fitchburg, | - | - | 4 | 14.3 | 17 | 60.7 | 4 | 14.3 | 3 | 10.7 | 28 |
| Gloucester, | - | - | 6 | 24.0 | 19 | 76.0 | - | - | - | - | 25 |
| Haverhill, | - | - | 4 | 13.4 | 24 | 80.0 | 1 | 3.3 | 1 | 3.3 | 30 |
| Holyoke, | - | - | 2 | 6.6 | 28 | 93.4 | - | - | - | - | 30 |
| Lawrence, | - | - | 6 | 12.0 | 35 | 70.0 | 8 | 16.0 | 1 | 2.0 | 50 |
| Lowell, | - | - | 24 | 26.6 | 50 | 55.5 | 16 | 17.7 | - | - | 90 |
| Lynn, | - | - | 26 | 43.3 | 33 | 55.0 | 1 | 1.7 | - | - | 60 |
| Malden, | - | - | 8 | 26.7 | 18 | 60.0 | 4 | 13.3 | - | - | 30 |
| Marlborough, | - | - | 1 | 7.1 | 13 | 92.9 | - | - | - | - | 14 |
| Medford, | - | - | 2 | 20.0 | 8 | 80.0 | - | - | - | - | 10 |
| Melrose, | - | - | 2 | 20.0 | 8 | 80.0 | - | - | - | - | 10 |
| New Bedford, | - | - | 3 | 4.8 | 55 | 88.7 | 4 | 6.5 | - | - | 62 |
| Newburyport, | - | - | 3 | 20.0 | 12 | 80.0 | - | - | - | - | 15 |
| Newton, | - | - | 5 | 26.3 | 14 | 73.7 | - | - | - | - | 19 |
| North Adams, | - | - | 6 | 27.2 | 16 | 72.8 | - | - | - | - | 22 |
| Northampton, | - | - | - | - | 11 | 100.0 | - | - | - | - | 11 |
| Pittsfield, | - | - | 6 | 27.2 | 16 | 72.8 | - | - | - | - | 22 |
| Quincy, | - | - | 5 | 25.0 | 12 | 60.0 | 3 | 15.0 | - | - | 20 |
| Salem, | - | - | 4 | 16.0 | 19 | 76.0 | 2 | 8.0 | - | - | 25 |
| Somerville, | - | - | 10 | 50.0 | 10 | 50.0 | - | - | - | - | 20 |
| Springfield, | 1 | 1.7 | 7 | 12.5 | 45 | 80.3 | 3 | 5.5 | - | - | 56 |
| Taunton, | - | - | 1 | 5.2 | 15 | 78.9 | 3 | 15.7 | - | - | 19 |
| Waltham, | - | - | 7 | 33.0 | 14 | 67.0 | - | - | - | - | 21 |
| Woburn, | - | - | 3 | 18.1 | 8 | 48.1 | 4 | 24.1 | 1 | 6.1 | 16 |
| Worcester, | 2 | 1.5 | 48 | 38.0 | 66 | 52.3 | 9 | 7.0 | 1 | .7 | 126 |
| Totals, | 15 | 1.1 | 325 | 23.7 | 940 | 68.7 | 80 | 5.9 | 8 | .6 | 1,368 |

| Grade A. | Per Cent. |
|---|---|
| Boston, | 4.1 |
| Springfield, | 1.7 |
| Worcester, | 1.5 |

| Grade B. | Per Cent. |
|---|---|
| Brookline, | 100.0 |
| Lynn, | 43.3 |
| Worcester, | 38.0 |
| Boston, | 33.5 |
| Waltham, | 33.0 |
| Cambridge, | 32.0 |
| North Adams, | 27.2 |
| Pittsfield, | 27.2 |
| Malden, | 26.7 |
| Lowell, | 26.6 |
| Newton, | 26.3 |
| Quincy, | 25.0 |

| Grade C. | Per Cent. |
|---|---|
| Northampton, | 100.0 |
| Holyoke, | 93.4 |
| Marlborough, | 92.9 |
| Brockton, | 89.8 |
| New Bedford, | 88.7 |
| Beverly, | 86.6 |
| Chicopee, | 85.7 |
| Fall River, | 83.3 |
| Chelsea, | 82.5 |
| Springfield, | 80.3 |
| Haverhill, | 80.0 |
| Medford, | 80.0 |
| Melrose, | 80.0 |
| Newburyport, | 80.0 |
| Taunton, | 78.9 |

| Grade D. | Per Cent. |
|---|---|
| Woburn, | 24.1 |
| Lowell, | 17.7 |
| Lawrence, | 16.0 |
| Taunton, | 15.7 |
| Quincy, | 15.0 |
| Fitchburg, | 14.3 |
| Malden, | 13.3 |
| Fall River, | 12.5 |
| Chelsea, | 10.0 |

| Grade E. | Per Cent. |
|---|---|
| Fitchburg, | 10.7 |
| Haverhill, | 3.3 |
| Lawrence, | 2.0 |
| Fall River, | 1.4 |

From analysis of this table it appears that 68.7 per cent. of the shops examined were of the type in which conditions are fair (Grade C); that 23.7 per cent. presented conditions well above the average (Grade B); while in about 1 per cent. the conditions found closely approximate the ideal (Grade A). In other words, it is apparent that in about 93 per cent. of the shops examined a fair to excellent degree of cleanliness was present alike on the premises and in the practices of the barbers. Of the 7 per cent. found to be below this standard, the conditions discovered, in the majority of instances, were such as to place the shops very much below the general average.

It is apparent from a study of the reports that in but very few barber shops are such precautionary measures as the disinfection of the shaving utensils systematically practised. It is further apparent that barbers are extremely negligent in the matter of washing their hands. The use of clean, individual towels is very generally prevalent in all but the poorest and dirtiest shops, although a certain degree of carelessness seems to exist in the protection of the towels from defilement by paper and otherwise; stick caustic is rather widely employed except in the larger cities, where in many instances the local boards of health have forbidden its use.

The investigation has yielded no direct evidence of the transference of disease from person to person in the barber shop, but it has demonstrated the existence of channels through which infection might easily pass. Chief among these are the fingers of the barber, the razor and the razor strops, the shaving brush and mug and the towels. These channels may readily be closed by the practice of strict personal cleanliness, supplemented by the scalding of the shaving utensils immediately before their use. Precautions of this sort, together with the elimination of such possible vehicles of contagion as powder puffs, sponges and stick or lump caustic, must very greatly diminish the chances for the spread of such diseases as impetigo contagiosa, folliculitis and syphilis.

The promulgating of rules governing barbers and for the protection of patrons of barber shops, together with the enforcement of such rules, by means of regular and intelligent inspection, are tasks which appear to lie wholly within the powers of the local boards of health of the cities and towns of the State. There is no possible doubt as to the desirability of such regulation, and in certain cities and towns rules for this purpose have already been adopted by the board of health, although it is evident that the enforcement of such rules is often very lax.

The following set of regulations is an example of such rules as are now operative in some of the cities and towns of this State, by order of local boards of health: —

### Regulations for Barber Shops.

Section 1. The place of business, together with all the furniture, shall be kept at all times in a cleanly condition.

Section 2. Mugs, shaving brushes and razors shall be sterilized by immersion in boiling water after every separate use thereof.

SECTION 3. A separate, clean towel shall be used for each person.

SECTION 4. Alum or other material used to stop the flow of blood shall be so used only in powdered form, and applied on a towel.

SECTION 5. The use of powder puffs is prohibited.

SECTION 6. The use of sponges is prohibited.

SECTION 7. Every barber shop shall be provided with running hot and cold water.

SECTION 8. No person shall be allowed to use any barber shop as a dormitory.

SECTION 9. Every barber shall cleanse his hands thoroughly immediately after serving each customer.

SECTION 10. Combs and brushes must be carefully washed and dried at least once a day.

SECTION 11. The drainage system of every barber shop in the city (town) of must be connected with the public sewer.

SECTION 12. Every barber doing business in the city (town) of shall record his name at the office of the board of health.

As the result of this investigation, it is the opinion of this Board that legislation providing for means of regulation or inspection of barber shops, other than such as already are afforded through the agency of local boards of health, is at the present time not necessary.

### PURIFICATION OF MYSTIC RIVER AND ALEWIFE BROOK.

Under the provisions of chapter 445 of the Acts of the year 1904, the State Board of Health was directed to prepare and report to the next General Court a method and plans for purifying Mystic River, Alewife Brook and the adjacent water courses, ponds and drainage areas, with due regard to the purposes indicated in chapter 327 of the Acts of the year 1903, entitled "An Act to authorize the cities of Cambridge and Somerville and the towns of Arlington and Belmont to improve the condition of Alewife Brook, Little River and Wellington Brook," and to the plans of the Metropolitan Park Commission for park developments within the said region, and after conference with the commission appointed under the above-mentioned act. An appropriation for carrying on this investigation was made under chapter 129 of the Acts of 1905; and on April 28, 1906, the following report was submitted to the Legislature: —

Acting under the provisions of section 2 of chapter 445 of the Acts of the year 1904, and chapter 129 of the Acts of the year 1905, the State Board of Health has examined the Mystic River and Alewife Brook and their drainage areas, and presents herewith a report of its investigations, together with its recommendations for purifying these waters, and preventing further injury to the public health by reason of unsanitary conditions existing in the valleys of these streams.

## Pollution of Mystic River and its Tributaries, and Methods by which Pollution can be prevented.

The main stream of the Mystic River from its mouth to Lower Mystic Lake receives little direct pollution compared with the volume of water passing through it, and the condition of its water is not such at the present time as to make it objectionable to those living near the banks of the stream in this portion of its course, excepting at places where polluting matters are discharged, or where a collection of offensive matter upon shores or flats exposed at low tide causes a local nuisance.

Near the mouth of the river, the city of Chelsea on its northerly side discharges all of the sewage from a large and populous area at a point near the bank of the stream at high water, and the sewage spreading over flats exposed at low tide causes a serious local nuisance. This sewer was formerly connected with the north metropolitan sewerage system, but the connection was shut off several years ago, owing, it is said, to the neglect of the Chelsea authorities to maintain the sewer in proper condition. The pollution of the river from this sewer could be largely prevented by reopening the connection with the metropolitan system, allowing only a portion of the mingled sewage and storm water at times of rain or when snow is melting rapidly to discharge at this outlet.

There are a few other sewer outlets in Charlestown, Somerville and Everett, through which mingled sewage and storm water are now discharged into the river at times of rain, but these outlets are not seriously objectionable under present conditions.

Farther up the stream, on the northerly bank, a small amount of pollution is caused by wastes from the New England Gas and Coke Works and the Cochrane Chemical Works; but these wastes are mostly mineral matter, and do not have a marked effect upon the stream.

The first principal tributary of the Mystic River above its mouth is the Malden River, which is very badly polluted at the present time by large quantities of manufacturing waste discharged into the stream in Malden and Everett. In the lower portion of its course this stream flows through a wide area of marsh land, and there are no dwellings in its immediate neighborhood. The water of the stream at its mouth is not offensive, though showing by chemical analysis marked evidence of the effect of the pollution it receives. Farther up stream the pollution becomes more noticeable, and just below Malden the river is offensive in appearance and odor. Above the central portion of Malden the condition of the stream grows better, and, though showing by chemical analysis evidence of considerable pollution, it is not offensive.

The pollution of the Malden River can be prevented by discharging the sewage and manufacturing wastes, which are now allowed to flow into the stream, into the north metropolitan sewerage system. Most of these wastes can be admitted directly to the sewers, though in some cases it may be

necessary to pass them through properly designed settling tanks for the removal of matters which the ordinary current of the sewer cannot carry along, or which might be objectionable in the sewers from other causes.

Upon the admission of Wakefield to the metropolitan sewerage system, several years ago, a new metropolitan branch sewer was constructed from the Wakefield boundary down to a connection with the old or former branch sewer in Malden. Below this point, while the sewer is still of ample size to remove, ordinarily, all of the sewage which it receives, and can easily receive also the wastes from the factories which now pollute the Malden River, observations show that at times of very wet weather in the spring the sewer becomes overcharged; and, while no considerable quantity of sewage has thus far been allowed to flow into local water courses at such times, it is evident that further relief will soon have to be provided for the main sewer in this valley, or a considerable quantity of sewage will have to be discharged into the streams at times of high flow. The Board is informed that the question of the relief of this sewer is already being considered by the Metropolitan Water and Sewerage Board.

Above the mouth of the Malden River the Mystic River is bordered by extensive salt marshes, and the most serious local pollution of the stream at the present time is that which is caused by the Hinckley Rendering Works, situated about half a mile above Wellington bridge. Waste matters from these works have formed a deposit upon the bottom of the river, which is offensive when exposed at low tide. Complaint was made by residents in the neighborhood of these works in 1905 of objectionable odors therefrom, and, as a part of a remedy for these odors, the Board advised that the wastes from these works be discharged into the sewers. It is understood that provision is now being made for connecting the works with the sewer.

Between the Hinckley Rendering Works and the outlet of Lower Mystic Lake, omitting for the present the consideration of the condition of Alewife Brook, the river receives no considerable pollution from any source.

Mill Brook, a tributary of Lower Mystic Lake, is polluted at several points by sewage from dwelling houses, and near its mouth by wastes from a gas works. The sewage pollution could readily be prevented by connecting the houses with the sewers, and abolishing the outhouses now in existence. The gas wastes should be kept out of the stream.

The shores of the lower and upper Mystic lakes are sparsely inhabited, and there is no local pollution of these waters.

The Aberjona River above Upper Mystic Lake flows through the thickly settled portions of Winchester, but it does not appear to receive any notable pollution in this portion of its course. Above Winchester the stream is badly polluted by sewage and manufacturing wastes, chiefly from factories located near its banks. The most serious of these pollutions is that caused by the wastes from the glue factory of the Baeder & Adamson Company, which already discharges a part of its wastes into the sewers. A considerable portion of them, however, is still allowed to overflow into the stream, seriously polluting it, especially at times when the water is low. This pol-

lution could be prevented by discharging all of the wastes into the sewer after passing them through settling tanks, or using such other means as may be necessary to prevent the admission to the sewers of matters which would be objectionable.

Considerable foul waste also enters the stream from a tannery below the glue factory, and from one or two other sources. Sewers are available for the disposal of these wastes, and the pollution of the stream can be prevented by discharging them into the sewers, after passing them through settling tanks, or providing such other treatment as may be necessary.

The most seriously polluted stream in the water-shed of the Mystic River above Upper Mystic Lake is Horn Pond Brook and its tributaries in Woburn. The pollution of this stream is caused chiefly by wastes from tanneries, all but one of which already discharge a portion of their wastes into the sewers. Certain of these liquids, however, are still excluded from the sewers, on account of the solid matters which they contain; and the streams in many places run beneath factories or through factory yards, and receive in these ways a considerable quantity of foul wastes from leaky floors and in other ways; and near the boundary line between Woburn and Winchester, the stream, known here as Russell Brook, is very foul in the summer season.

One of the tanneries in Woburn is situated beyond the limits of the sewered district, but a sewer could readily be extended to receive the foul wastes from these works. If this should be done, and if further means should be provided to insure the discharge of tannery wastes from the various tanneries into the sewers by providing tight floors in the buildings, the further nuisance in the streams in this neighborhood could be prevented.

The nuisance caused by the pollution of Russell Brook, in Winchester, by tanneries in Woburn, has been one of long standing; and, as the matter now stands, unless the city of Woburn chooses to take such action as will prevent the pollution of the stream, the town of Winchester appears to have no protection from this nuisance.

An examination of the capacity of the main branch of the metropolitan sewerage system in Winchester shows that this sewer also is now overtaxed at times of maximum flow in the spring, and that sewage sometimes rises in the man-holes to a depth of several feet. It is not probable that any sewage has overflowed from the sewer in this neighborhood as yet; but the sewer is not capable of carrying at times of maximum flow a much greater quantity of sewage than it now receives, and, unless measures are taken either to reduce the quantity of water entering the sewer or to provide a sewer of larger capacity, sewage will be likely to overflow and cause the pollution of local waters. Such overflows would, in the beginning at least, take place only in extremely wet weather, when the sewage would have a less noticeable effect upon the streams than at other times; but relief should be provided as soon as practicable.

Alewife Brook is one of the most seriously polluted streams in the Mystic River water-shed. While the water-shed of the stream is quite densely populated, especially on the easterly side, there are still numerous farms in

the valley which are very highly cultivated, and great quantities of manures and fertilizers of various kinds are used upon these lands. In consequence, most of the streams tributary to Alewife Brook give evidence of a high degree of pollution, either by the presence of organic matter, or, more commonly in the upper part of the water-shed, of mineral matter in the form of nitrates, derived probably in part from manures and fertilizers used on the farms and market gardens in this region, and in some part also from leachings from cesspools, etc., filtering through the ground to the ponds and streams.

The main streams in the upper part of this water-shed — Wellington Brook and Winn's Brook — are not polluted in such a degree as to make them objectionable to those living in their neighborhood; and the water of Little River, which receives the flow of these brooks, including Spy and Little ponds, is also inoffensive at the present time, though containing large quantities of mineral matter and considerable numbers of microscopic organisms.

The main stream of Alewife Brook is badly polluted by the discharge of foul wastes from a tannery, which enter the stream through Tannery Brook, in the neighborhood of Massachusetts Avenue below the main portion of the marshes on that stream. The quantities of liquid wastes from this tannery vary greatly from time to time, but have been found to amount at times to nearly 100,000 gallons per day, while the quantity of putrescible organic matter contained in these wastes amounts to from five to ten times the quantity of such matter found in ordinary sewage.

A glue factory near the upper end of the Alewife Brook water-shed discharges foul wastes into marshes bordering the stream, badly polluting several pools in the neighborhood of Concord Avenue. The stream also receives considerable pollution from manure piles and other sources.

The chief pollution of Alewife Brook is that which is caused by the overflow of sewage from the combined systems of sewers in the city of Cambridge, at times of rain or when snow is melting rapidly. The water-shed of Alewife Brook is very thoroughly provided with sewers, which are connected with the Alewife Brook branch of the metropolitan sewerage system. Most of these sewers are constructed upon the separate plan, with the intention of excluding rain water; but in three districts, in Cambridge, the sewers are built upon the combined plan, and take rain water as well as sewage. These sewers were in existence at the time the metropolitan sewer was constructed, and, as in the case of other similar sewers, the metropolitan system was not designed to take all of their flow; but provision was made for receiving into the Alewife Brook branch all of the sewage flowing in these sewers in dry weather and a portion of the mingled sewage and storm water at times of rain, allowing the remainder above the capacity of the metropolitan sewer at such times to overflow into Alewife Brook.

Calculations show that the quantity of sewage discharged into Alewife Brook in this way is large enough to cause gross pollution of the stream in dry weather; and observations during the past year show that the stream is

grossly polluted at such times, and very offensive to those living in its neighborhood, especially in the region above Massachusetts Avenue, where the water available for the dilution of the sewage is only that which flows naturally from the Alewife Brook water-shed. The effect of the pollution diminishes below Massachusetts Avenue, chiefly on account of the dilution by tide water which runs up the stream to this neighborhood.

Whatever provision may ultimately be made for the drainage and improvement of the marshes along Alewife Brook and elsewhere in the Mystic River water-shed, there is no doubt, in the opinion of the Board, that the best plan of preventing the further pollution of Alewife Brook by sewage from the combined sewers, which now discharge into that stream, is to separate the sewage from the storm water in these combined areas; since the rain water and ground drainage, if unpolluted by sewage, could be discharged into local waters without objection, and all of the sewage proper could then be removed from the district in the metropolitan sewers at all times.

It is evident, from an examination of the sewers tributary to the Alewife Brook branch of the north metropolitan sewerage system and the records of the quantity of sewage flowing at different times, that some of them are already overcharged at times of wet weather, owing to the entrance of excessive quantities of water at such times, particularly in the spring. This is especially true of the branches from Belmont and Arlington, and, while some relief has been provided by rebuilding some of the sewers in the former town, further relief will soon be necessary. In the case of the Arlington sewer also an enlargement is likely to be required when sewers are built in the town of Lexington, which has recently been admitted to the district, and the sewage from which must find its way into the metropolitan system through the Arlington sewer, unless a new sewer shall be constructed.

Under the conditions prevailing in this valley, it is likely that the pollution of the streams by sewage from other sewers than the combined systems in Cambridge will result, unless some relief shall be provided. Whether this can best be done by enlarging the metropolitan sewers, or preventing the entrance of unnecessary quantities of water from the tributary systems, is a matter for further and immediate investigation.

## Malaria in the Valley of Mystic River and Alewife Brook, and the Measures necessary to prevent its Further Spread.

Our investigations during the past year show that malaria prevails to a most alarming extent in the region about the Alewife Brook marshes, and is spreading rapidly. Numerous cases were found also along Mystic River, especially along its southerly side, from the mouth of Alewife Brook down to the neighborhood of Malden River. Few cases were found in other portions of the valley, though there have been many cases in past years in the neighborhood of Horn Pond in Woburn.

The fact is now well established that malaria is carried from person to

person by mosquitoes of the genus Anopheles. Careful investigations during the past year of the ponds, streams and other waters in the Mystic River water-shed, show that Anopheles mosquitoes breed in great abundance in pools, ditches and sluggish streams in the Alewife Brook marshes. The numerous abandoned clay pits in the region of the Alewife Brook marshes were found, with one or two exceptions, to be free from these organisms; but they were breeding in certain abandoned clay pits in Medford, and in other places along the southerly side of Mystic River between Alewife Brook and the mouth of Malden River. They were not found, however, in Mystic River or in the pools or channels of the salt marshes bordering that stream, though mosquitoes of the genus Culex breed in enormous numbers in the marshes above Wellington bridge, and, while not known to be carriers of disease, are a serious nuisance. Anopheles mosquitoes breed in small numbers in the region of Mill Brook in Arlington and in other parts of the Mystic River water-shed, notably in Wedge Pond in Winchester, in certain shallow pools along Cambridge Street in that town and in a shallow portion of Horn Pond in Woburn; but very few cases of malaria were found outside of the immediate neighborhood of Alewife Brook and of Mystic River between Alewife Brook and Malden River.

With our present knowledge of the cause of malaria and the means by which it is disseminated, the best practicable plan of preventing its spread is to exterminate the Anopheles mosquitoes, — the carriers of the disease. This can best be done by abolishing the breeding places of the organisms, or by so changing the condition of the pools, streams, ditches, etc., in which breeding now takes place as to make them unfavorable in the future for this purpose. The breeding of mosquitoes in some of the pools and ditches in the Alewife Brook marshes could doubtless be prevented either by poisoning the water so as to kill the larvæ, or by covering it with oil so as to prevent them from obtaining access to the air, thus causing their destruction. It would evidently be possible also to drain some of the pools so that water would not ordinarily remain standing in them in the summer season, and some of the smaller pools could be filled with earth or other material at no great expense. These methods can no doubt be employed to advantage in treating many of the ponds and pools in the valley of Mystic River in which Anopheles mosquitoes were found to be breeding during the past year; but the only practicable plan, in the opinion of the Board, by which the breeding of Anopheles mosquitoes in the Alewife Brook marshes and the further spread of malaria can be prevented is by draining these marshes thoroughly, so that water will not stand upon them during the period when Anopheles mosquitoes are liable to breed, from early April to the last of November.

Portions of the Alewife Brook marshes are below the level of ordinary high tide in Boston harbor, and all of these marshes and considerable areas of highly cultivated lands about them are below the level to which spring tides in Boston harbor frequently rise. Under these conditions, any drainage system for these marshes, to be effective and satisfactory, must include a

provision for keeping the water of high tides from flooding the marshes, else valuable farming lands are likely to be injured, and other damage result.

It is also essential at the same time that reservoirs of adequate capacity be provided to store the water accumulating above the tide gates during the period of high tide at a sufficiently low level to prevent it from flooding the marshes, and that channels and sluices of adequate capacity be provided to draw off at low tide the water which has accumulated in the period of high tide. These channels should be so constructed as to be unfavorable as breeding places for mosquitoes, and the water should be kept in a proper sanitary condition.

The Board considers such a drainage system essential for the prevention of the further spread of malaria and the great amount of sickness now being caused by that disease in the region about Alewife Brook.

Section 2 of chapter 445 of the Acts of 1904, under which these investigations have been made, provides that, in preparing a plan for purifying Mystic River, Alewife Brook and adjacent water courses, ponds and drainage areas, the Board shall confer with the commission appointed under chapter 327 of the Acts of the year 1903, entitled, "An Act to authorize the cities of Cambridge and Somerville and the towns of Arlington and Belmont to improve the condition of Alewife Brook, Little River and Wellington Brook," and shall have due regard for the plans of the Metropolitan Park Commissioners for park developments in this region.

Upon consulting with the commission appointed under the act of 1903, it appeared that at the time this act was passed it was the understanding that the cost of the work of improving the condition of Alewife Brook, Little River, etc., would amount to about $10,000; but no definite plans appear to have been made of the work to be done with this amount of money, except that in general it was proposed to provide tide gates near the mouth of Alewife Brook.

The plans of the Metropolitan Park Commission for park developments in this region, as at present proposed, provide for a dam in Mystic River at Cradock bridge, designed to maintain the water above the dam at approximately grade 7, and allow for the building of parkways now contemplated on both sides of the stream between Cradock bridge and Lower Mystic Lake, at a level approximately 3 feet lower than would be necessary if no dam were constructed. For the sub-grading of these parkways material is already being taken from Mystic River, between Lower Mystic Lake and Cradock bridge.

If the proposed dam be built at Cradock bridge, with an ample channel excavated from the dam up to the mouth of Alewife Brook, it will render unnecessary a dam at the mouth of Alewife Brook, and will be not only "consistent with the improvement and purification of Mystic River and Alewife Brook," but will be a very important step taken toward such improvement; still, there will remain much to be done upon the brook and its branches to prevent the growth there of the mosquito which causes the spread of malaria.

If, as was formerly contemplated by the commission appointed by chapter 327 of the Acts of 1903, a dam and tide gates had been constructed at the mouth of Alewife Brook, the investigations of this Board show that, in order to make such tide gates effective in keeping the low lands of this drainage area from being flooded by rains which come during the breeding season of the Anopheles mosquito, it would be necessary to enlarge the channel of Mystic River from the mouth of the brook to Cradock bridge to about the extent proposed by the Metropolitan Park Commission; hence, the work proposed by this commission relieves the Alewife Brook drainage area from the expense of building a dam at the outlet of the brook, and of enlarging the channel of the Mystic River down stream from the mouth of the brook.

The dam at Cradock bridge and the enlargement of the channel of Mystic River up to Mystic Lake would serve the additional purpose of putting this section of the River in good sanitary condition.

To remove the existing unsanitary conditions of Alewife Brook and its branches, the sewage now polluting it should be excluded. There are three districts in Cambridge, including an area of nearly 1 square mile, where the sewers convey sewage and storm water which rapidly fills the metropolitan sewer, and the surplus overflows into Alewife Brook, grossly polluting this stream throughout the year. This Board sees no effectual way of preventing this but by separating the sewage from the storm water in these districts, discharging the sewage into the metropolitan sewer, closing the outfalls, and conducting the storm water into the natural water courses. The other outfalls along this brook should be permanently closed.

Sewage being excluded from Alewife Brook and its branches, and the water in Mystic River being held ordinarily near grade 7, provision should be made for holding the water of the brook throughout its length, with its branches up to and including Little Pond and Spy Pond, at about the same grade during dry weather. This would require deepening of all of these channels, and at such times this water would stand between 2 and 3 feet below the surface of the large area of swamp land thus drained.

When the tide rises above grade 7 at Cradock bridge the gates there would close, and, during the next four or five hours, the water coming down through Mystic River and through the several feeders of Alewife Brook during dry weather would spread out over Lower Mystic Lake, Spy Pond, Little Pond and the channels above the dam to a depth of between 1 and 2 inches, and this would be drawn down again in the five or six hours when the tide is below grade 7.

After a heavy summer rain that would discharge into this storage basin, in twenty-four hours, the equivalent of one-half an inch of rain over the whole drainage area, the storage basin would be raised above the normal height about 1 foot in the hours when the tide gates are closed; and, unless the channels leading from Spy Pond and Little Pond are large enough to convey away this storage and as much more water constantly coming into the storage area, and draw it down to near grade 7 in the hours when the tide gates are open, the water, during the second high tide, would rise higher

in these channels and storage areas, and during the third high tide still higher, and would overflow the low marsh area and leave pools for mosquito breeding.

To prevent this, the channels of Alewife Brook and its branches up to Little and Spy ponds should be enlarged. They should be large enough to allow any amount of water that is likely to come during the breeding season of the Anopheles mosquitoes to flow out from the storage basins during the hours of low tide without overflowing the banks. Beyond this it would be best to make them somewhat larger, to limit the height to which water might rise over the low areas during the greater freshets when the ground is frozen.

Such a channel would be about 2.35 miles in length, with its bottom at about grade 1 at the lower end and grade 2 at the upper end, and of a width at the bottom near the lower end of about 27 feet and near the upper end of about 23 feet, with flat side slopes. For about half of its length it would be necessary to build this channel with paved slopes, in order to keep it in proper condition and prevent the breeding of mosquitoes therein. The total amount of excavation for this channel would be about 125,000 cubic yards, in addition to which it would be necessary to enlarge the water way at the street crossings.

The course selected for such a channel differs in some places from that of the present brook, in order that it may be straighter and run through firm soil, in which its form may be maintained, and to avoid deep deposits of muck. It may be desirable still further to modify the course when park roads or other improvements in this marsh area may be planned.

While the work of constructing these channels and other work of improvement of these marsh areas is in progress, it will be important to have the co-operation of the Metropolitan Park Commissioners, in control of the dam at Cradock bridge, where the water of the Mystic River may be drawn and held for the dry time at a level some feet below the proposed permanent grade of 7.

In addition to the main channel, it will be necessary to construct many branch channels and grade the surface of the marsh area, so that rain-water pools may not form upon it. The branch channels should also be so made that pools may not be formed in them at any time in the summer. To accomplish this, the Board would recommend the cutting of channels about 18 inches wide to a depth of grade 6.5 near the main channels, with the bottom grade rising very slowly, — perhaps 1 foot in 1,000 or 2,000 feet, — filling the lower 6 inches with coarse gravel, without sand; then laying upon this gravel a drain pipe of size depending upon the area to be drained, but small, in order to carry only soakage from the ground; this pipe should be laid with open joints, and the trench around and above it should be filled with gravel without sand up to a height about 1 foot below the general surface of the marsh, but rising slowly, going from the main channel like the drain pipe; and the surface of the marsh should then be graded from the top of this gravel, rising slowly, to prevent the formation of pools and to allow all surface water to drain towards these gravel depressions and be conveyed

by them to the main channel. After the surface water has run away the drain pipes below will drain the gravel and the land on either side of it.

Wellington Brook will enter the main channel at Perch Pond. Above Perch Pond it should be deepened sufficiently to drain the low land bordering it as efficiently as the other low area is drained.

The bed of Alewife Brook above the junction with Little River should be excavated 30 inches wide and 8 inches below the following grades, and filled with gravel without sand to grade 6 at the lower end and grade 7 at the upper end; and upon this a 12-inch drain pipe should be laid with open joints up to the entrance from Glacialis, up stream from which, to near Concord Avenue, an 8-inch pipe should be laid, such pipes having occasional small branches on either side. The gravel filling should then be continued to an equal width up to grade 8 at the lower end and to grade 9 at the upper end. The adjoining land should be graded, rising slowly from the gravel to the surface.

A similar pipe and gravel drain should extend up the easterly side of the old Lexington & Arlington Railroad.

Farther east, the clay pits are generally surrounded by higher land, and their waters can be lowered where desired by rain-water drains from their territory. The low area around Pout Pond can be drained by a pipe laid similarly to that along upper Alewife Brook, and extending from Pout Pond under the Fitchburg and the Central Massachusetts railroads to the main channel, the portion under the railroads being of cast-iron pipe, with tight joints.

The portion of Little River abandoned by making the new main channel should be treated in the same way as the upper end of Alewife Brook.

The total cost of deepening the main channel of Alewife Brook from Mystic River up to Little Pond, of making it large enough to provide adequate drainage for the marshes, together with the cost of main tributary drains herein mentioned, and of enlarging bridges, culverts, etc., exclusive of land damage, is estimated to be $95,000.

The channel of the brook and its tributaries lies for the most part through lands having at present very little value, so that the land damage is not likely to add materially to the cost.

Anopheles mosquitoes were found to be breeding in clay pits in the low land easterly from Tufts College, and in a pool in the stone quarry southeasterly therefrom. Malaria was found to be common in the houses near these breeding places. The land around these pools is above high tide, and it can be filled or drained without keeping out the tide. Malaria was found in a few other localities in the valley of the Mystic River below Cradock bridge; but the objectionable features can probably be removed without great expense. A few Anopheles mosquitoes were found to be breeding in one of the mill ponds on Mill Brook in Arlington, in Wedge Pond in Winchester, in certain pools along Cambridge Street in that town and in Horn Pond in Woburn. The breeding of mosquitoes in the mill pond on Mill Brook can be prevented by deepening the edges of the pond and keeping

it free from growths of filamentous algæ and water weeds; and the development of these organisms in the pools along Cambridge Street in Winchester can be prevented by similar treatment. It will be more difficult to prevent the breeding of Anopheles mosquitoes in Wedge Pond and Horn Pond, in the shallow portions of which a few Anopheles mosquitoes developed during the past year, protected by growths of filamentous algæ and aquatic plants. By keeping the shores and shallow places in those ponds free from excessive growths of this sort, the breeding of Anopheles mosquitoes can be prevented.

The great area of salt marsh land subject to flooding by the tide between Cradock bridge and Wellington bridge, having an area of about 374 acres, was not found to contain breeding places for Anopheles mosquitoes. They prefer fresh-water pools. This large area of marsh land and perhaps a bordering area as large at a little higher elevation could be made more valuable and beautiful if the tide were shut out from it by a dam above Wellington bridge, and the water held at about grade 7, as proposed above Cradock bridge. There would be a further advantage with a dam above Wellington bridge affecting the Alewife Brook marsh area, in that the storage basin would be larger, and would enable the overflow in very extreme winter and spring freshets to be kept down about 6 inches lower than with a dam at Cradock bridge. Such an overflow, which may reach to the height of 11.5 over the upper end of Alewife Brook marshes once in a generation, would occur at a season when it would not produce malaria.

While the Board recognizes great advantages to the community in reclaiming this large area so near to the metropolis, it does not find that this is necessary to protect the public health. The present objection to building a dam immediately above Wellington bridge is the extra cost, which would probably amount to $175,000 more than the dam at Cradock bridge. Were the Wellington bridge to be rebuilt in the future, a dam could probably be built there that would serve as a bridge without much greater cost than that of a permanent bridge.

## Water Supply and Sewerage.

The State Board of Health presents herewith a report of its doings for the year ending Nov. 30, 1906, under the provisions of laws relating to the protection of the purity of inland waters, as required by chapter 75, section 115, of the Revised Laws.

The Board has received during the year 130 applications for advice with reference to water supply, sewerage, sewage disposal and matters relating thereto. Of these applications, 88 were in relation to water supply, 6 to sources of ice supply, 26 to sewerage, drainage and sewage-disposal systems, and 10 to miscellaneous matters.

## EXAMINATION OF WATER SUPPLIES.

Public water supplies were introduced during the year in the towns of Dracut, Edgartown and Oxford. At the end of the year, 184 of the 354 cities and towns in the State were provided with public water supplies. All of the cities and towns of the State having a population, according to the census of 1905, in excess of 3,500, are now provided with public water supplies, except the towns of Barnstable, Blackstone, Chelmsford,[1] Dartmouth, Dudley, Templeton and Tewksbury. The cities and towns having public water supplies contain approximately 93 per cent. of the total population of the State.

The usual chemical and microscopical analyses of the waters of public water supplies have been continued, and bacterial examinations have been made of most of the ground waters. The total number of sources examined during the year was 273, many of which have been inspected by the engineer of the Board or his assistants.

Attention was called in the report of last year to the objectionable conditions affecting the water supplies of the city of Lynn and the towns of Franklin and Great Barrington. By the provisions of chapter 509 of the Acts of the year 1906 the State Board of Health and the water board of the city of Lynn are authorized and directed to investigate plans for enlarging and improving the water supply of the city of Lynn, and the results will be presented in a separate report.

Investigations have been made during the year by the Franklin Water Company with a view to obtaining a better water supply for that town, and the advice of the Board has been requested as to the use of water to be taken from wells near the westerly end of Beaver Pond. The results of a pumping test indicated that water of good quality could probably be obtained from the proposed source in sufficient quantity for the supply of the town, and the Board recommended that this source be used and the present sources abandoned. The construction of works for introducing water from the new source was begun toward the end of the year, but was interrupted by cold weather, and the work is not yet completed.

No change has been made in the sources of water supply of the Great Barrington Fire District, and the district continues to draw most of its supply from the Green River. This stream drains an area of about 52 square miles, 29 of which are in Massachusetts and 23 within the limits of the State of New York. In the portion of the water-shed outside of the State of Massachusetts are many dwelling houses and out-buildings, some of which are located on the banks of the stream or its tributaries,

[1] Works under construction.

and a population of 900 lives within the water-shed in Massachusetts. The water is drawn directly from the stream, and under these conditions the continued use of the source is a menace to the health of the district.

*Water Supply of Lawrence.*

Early in the year a contract was made by the city of Lawrence for the construction of a covered sand filter to increase the capacity of the works for filtering its water supply, which is drawn from the Merrimack River. The new filter had not been completed at the end of the year when the work was interrupted by cold weather, and no portion of it can be made available for use within the coming winter. It is improbable that, even in an ordinary winter, enough water can be obtained from the present filter to furnish an adequate supply for all purposes; and, unless an additional supply can be obtained from neighboring towns, it will be necessary for the city to draw a portion of its water supply directly from the Merrimack River without filtration.

The works of the town of Andover and those of North Andover are capable of furnishing a sufficient additional supply to the city of Lawrence to meet the present emergency and to make the use of the unfiltered Merrimack River water unnecessary, and these towns can supply this water without inconvenience to their own citizens.

Authority is granted to cities and towns to purchase water temporarily from other cities and towns in cases of emergency, by section 35 of chapter 25 of the Revised Laws, as amended by chapter 361 of the Acts of the year 1902. Under this law a city or town having a system of water supply may purchase water from any city, town or water company for a period of not more than six months in any one year, in such quantities as may be necessary to relieve the emergency, provided the source is approved by the State Board of Health.

*Rules and Regulations for preventing the Pollution and securing the Sanitary Protection of Waters used as Sources of Public Water Supply.*

By the authority of chapter 75, section 113, of the Revised Laws, the State Board of Health is authorized to make rules and regulations to prevent the pollution and secure the sanitary protection of all waters used as sources of public water supply. Under this law the Board has from time to time, as requested by the authorities of a city or town, made such rules and regulations for the sanitary protection of its sources of water supply as were in its judgment necessary and adapted to the purpose. In all, the water supplies of 38 cities and towns are now protected by such rules, exclusive of cities and towns in the metro-

politan water district, rules for the protection of which were made by this Board under the provisions of the metropolitan water act, which provides for their enforcement by the Metropolitan Water Board.

Rules and regulations made previous to 1906 prohibited the use of sources of water supply for boating, fishing and ice cutting, unless carried on under a special regulation or written permit of the local authorities charged with the control of the sources of supply. On April 3, 1906, in the case of the Commonwealth *v.* Nathaniel G. Staples, it was decided by the Supreme Court that the law authorizing the State Board of Health to make rules and regulations for the protection of public water supplies does not authorize the Board to delegate to others the granting or withholding of permits, and that regulations delegating such authority are void. The effect of this decision is to make it necessary that the regulation of boating, fishing and ice cutting on sources of public water supply and the granting of permits to enter upon such sources for these purposes shall be made by this Board. The matter was brought to the attention of the Legislature last year late in the session, but no change was made in the law.

Amendments have since been made by the Board in existing rules and regulations when requested by water boards or boards of health, requiring that permits for boating, fishing and ice cutting on the waters of these sources should be obtained from the Board. Numerous petitions have since been received for permits to boat and fish on certain of the sources. especially on Assawompsett Pond (one of the sources of water supply of the city of Taunton) and on Wenham Lake (one of the sources of water supply of the cities of Salem and Beverly); and the Board has granted a limited number of such permits, with restrictions as to the area within which such rights shall be exercised.

Early in the summer petitions were received from the towns of Barnstable, Boxford, Carver, Chatham, Chesterfield, Easton, Falmouth, Freeport, Grafton, Groton, Hadley, Hancock, Hanson, Lakeville, Lee, Leyden, Lunenburg, Middleborough, Milford, Monroe, New Braintree, North Attleborough, Orange, Paxton, Pelham, Plymouth, Plympton, Rochester, Rockport, Royalston, Sharon, Sherborn, Shirley, Stoneham, Walpole, Wellesley, Wenham, Westborough, West Brookfield, Whitman, Williamstown and Worthington, and from Charles S. Smith of Lincoln, requesting that a public hearing be given on the question of amending the existing regulations or promulgating entirely new rules governing all great ponds in the State used as sources of water supply, to the end that "such rules and regulations may be promulgated as are reasonable and necessary for the preservation of the purity of the water of every State pond used as a source of water supply;" and in response to these

petitions a hearing was given on Aug. 2, 1906, after notice to the mayor of every city and the board of selectmen of every town within the Commonwealth. At this hearing no one appeared to represent the petitioners, and after a few general remarks by persons who favored a freer use of sources of water supply for boating and fishing, and by others who desired to have the purity of drinking water protected as completely as possible, the meeting adjourned.

In the opinion of the Board, the danger to the public health involved in the unrestricted use of sources of water supply for boating, fishing and ice cutting is unquestionably a very serious one, and the protection of the public health requires in some cases the absolute prohibition of the use of reservoirs or ponds for these purposes. On the other hand, in some cases such uses are allowable, under proper restrictions.

Hitherto the rules and regulations made by the State Board of Health have been enforced by local water boards or boards of health through their officers or agents, with satisfactory results. Under present conditions, however, it is necessary for those desiring permits for boating, fishing, ice cutting, etc., on sources of public water supply to present their requests at the State House, instead of, as formerly, to the local authorities controlling the sources of water supply upon which entrance was desired.

In the opinion of the Board, the regulation of boating, fishing, ice cutting, etc., on sources of water supply can be carried out best by the local authorities responsible for the sources in question, under the advice of the State Board of Health; and the Board would recommend the passage of an act authorizing it to delegate authority to grant or withhold permits for boating, fishing, ice cutting, etc., to local authorities, subject to its advice and regulation. In this way the Board believes that the sources of water supply can be adequately protected, and their use for the purposes indicated preserved to the public with the least possible inconvenience to the public.

### *Examination of Sewer Outlets, — Pollution of Stony Brook.*

Complaints have been made to the Board that a very serious nuisance exists in the Charles River in the neighborhood of the outlets of Stony Brook; and an examination of the waters of the Stony Brook channels during the past year shows that they are being much more seriously polluted than formerly, and that the flats in the river about these outlets are covered with foul deposits, evidently from sewage.

The pollution of Stony Brook has been a source of nuisance for many years. After the great flood of 1886 a new channel for the brook was constructed from Roxbury Crossing to the outlet at the Back Bay Fens,

and has since been extended from Roxbury Crossing up stream, and is now completed to a point between Jamaica Plain and Forest Hills. Above Roxbury Crossing, wherever deviations from the existing line of the stream were made the old channel was abolished; but below that point the old channel of Stony Brook still exists from Roxbury Crossing to the Fenway, and an extension of it runs to Charles River. Recently the new channel, known as the commissioners' channel, has been extended from its original outlet into the pond in the Back Bay Fens to Charles River, and both the old and the new channels now discharge into the river at the outlet of the stream from the Fens.

The old channel of Stony Brook, which is about 1.5 miles in length, now serves both as a conduit for the removal of storm water overflowing from combined systems of sewers at times of rain or when snow is melting, and also as a sewer for the removal of the sewage from low areas in its neighborhood. Its condition above the Fenway has been referred to frequently in the reports of the street department of Boston, from which the following extract is taken (report of the street department of Boston for 1900, pages 193, 194): —

The old Stony Brook channel from the gate-house in the Fenway opposite Bryant Street to the premises of the Boston Belting Company on Elmwood Street is built of rubblestone; part of the distance the construction being a double arch of dry rubble and part a double channel of square section, the side walls being loose rubble and the covering stone granite slabs. Both of these sections are in very precarious condition, the rubble arches being so loose that stones can be pulled out by hand from the inside. . . . On the square section the granite covering stones are continually breaking in the middle, and have been replaced in many places with timber. In other places the stones have been shored up with timber bracing. It is feared that either one of these sections may collapse at any time, and cause serious and expensive accidents. This channel should be rebuilt throughout its entire length in order to be safe, and at the time of rebuilding pipe sewers should be built on each side, to take the drainage of abutting estates which are too low to drain into the existing sewers. Pollution unavoidably finds its way into this channel from these estates, and will continue to do so until they are provided with proper sewerage.

The new channel of Stony Brook, known as the commissioners' channel, receives the flow of the stream and its tributaries above Forest Hills and the overflow of sewage from combined sewers in the densely populated areas tributary to the stream below that point at times of storm. It also receives considerable drainage from factories, chiefly from breweries in Roxbury.

The main sewer in the valley of Stony Brook is tributary to the

Boston main drainage system, which was designed for the removal of all the sewage of combined sewers in the Boston main drainage district in dry weather, and, in addition, a small portion of the water entering the sewers at times of rain.

The capacity of the Stony Brook branch sewer is probably too small for the district which it is designed to serve, as is shown by the following extract from the report of the street department of Boston for 1901 (page 224) relative to the objectionable conditions in the valley of Stony Brook and in the Fenway: —

> Another circumstance which aggravates the condition of things is that the main sewer in the Stony Brook valley is but little larger than is necessary to carry the dry-weather flow, so that comparatively light rainfalls cause overflows of but slightly diluted sewage into the brook.

The increasing pollution of the Stony Brook channel appears to be due to the increasing quantity of sewage which it receives not only in storms but in dry weather when the flow of sewage exceeds the capacity of the main sewer. There is evidence also that connections between tributary sewers and the main Stony Brook valley sewer sometimes become clogged, and that at such times a large portion or the entire flow of a tributary sewer is discharged into the Stony Brook channel.

Examinations of the sewer outlets in the Charles River in the Back Bay district show that sewage flows directly into the river from some of these outlets, even in dry weather, when the main drainage system is capable of removing their entire flow.

Under the legislation authorizing the construction of a dam across Charles River at Craigie bridge, provision is made for the construction of a marginal conduit from the Fenway and possibly from St. Mary's Street, farther up stream, along the southerly side of Charles River to a point of discharge into the river below the dam, for the purpose of receiving and removing the dry-weather flow of the Stony Brook channels, including part of the overflow both from these channels and from combined sewers in the Back Bay and West End districts of Boston at times of storm, to an outlet below the dam whenever the stage of the tide permits such discharge. The Stony Brook channels and sewer overflows are to discharge at other times directly into the new basin.

In the report of the engineer to the committee on the Charles River dam, apprehension is expressed that a nuisance might be created at the outlet of the marginal conduit below the dam, which is close to the North Union Station, by the foul discharge from this conduit; and later a similar fear was expressed by the officials of the street department of

Boston, and an appeal was made to the Legislature by that city for the omission of the construction of the proposed marginal conduit, proposing, instead, the separation of the sewage from the storm water in the districts from which sewage may find its way into the Charles River, so that all sewage might be diverted from the basin. This plan, which, if fully carried out, would have removed permanently the nuisance caused by the discharge of sewage into the Stony Brook channels and Charles River, and have prevented danger of future nuisances from this cause, was finally rejected.

The information available to the Board shows that the sewerage and drainage of these districts is inadequate and unsystematic; and, unless a practicable and adequate plan for the collection and proper disposal of the sewage, rain water and other drainage of these districts shall be devised and intelligently carried out in the future, objectionable conditions resulting from the present faulty sewerage and drainage systems will inevitably grow worse.

The Board would recommend that an investigation be made and plans prepared for the adequate sewerage and drainage of the Stony Brook valley and the districts adjacent to the Charles River in the city of Boston.

### *The Neponset River.*

The enactment of chapter 360 of the Acts of 1906, entitled "An Act to provide for the protection of the public health in the valley of the Neponset River," strengthens very materially the legislation designed for the prevention of the nuisance resulting in the pollution of the Neponset River. Soon after the passage of this act the Board issued the following notice to those cities and towns and persons who were found to be discharging sewage or other polluting matters into the stream and its tributaries: —

COMMONWEALTH OF MASSACHUSETTS,
OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, July 5, 1906.

ORDER OF THE STATE BOARD OF HEALTH.

The State Board of Health, acting under the authority of chapter 360 of the Acts of the year 1906, hereby prohibits the entrance or discharge of sewage into any part of the Neponset River or its tributaries, and the entrance or discharge therein of every other substance which may be injurious to public health or may tend to create a public nuisance.

By order of the Board,

A true copy. Attest:

*Secretary.*

[CHAPTER 360.]

AN ACT TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH IN THE VALLEY OF THE NEPONSET RIVER.

*Be it enacted, etc., as follows:*

SECTION 1. Section one of chapter five hundred and forty-one of the acts of the year nineteen hundred and two is hereby amended by striking out all after the word "nuisance," in the sixth line, so as to read as follows: — *Section 1.* The state board of health is hereby authorized and directed to prohibit the entrance or discharge of sewage into any part of the Neponset river or its tributaries, and to prevent the entrance or discharge therein of every other substance which may be injurious to public health or may tend to create a public nuisance.

SECTION 2. Section two of said chapter five hundred and forty-one is hereby amended by striking out the words "any such owner," in the second line, and inserting in place thereof the words: — the owner of any factory or other establishment, — by striking out the word "such," in the fourth line, and inserting in place thereof the word: — the, — by inserting after the word "refuse," in the same line, the word: — therefrom, — and by striking out all after the word "harmless," in the fourth line, so as to read as follows: — *Section 2.* The board shall consult and advise with the owner of any factory or other establishment at his request or of its own motion as to the best practicable and reasonably available means of rendering the waste or refuse therefrom harmless.

SECTION 3. Section three of said chapter five hundred and forty-one is hereby amended by striking out the words "or of any other party in interest," at the end of said section, so as to read as follows: — *Section 3.* The supreme judicial court or any justice thereof and the superior court or any justice thereof shall have jurisdiction in equity to enforce the provisions of this act and any order made by the state board of health in conformity therewith. Proceedings to enforce any such order shall be instituted and prosecuted by the attorney-general upon the request of the state board of health.

SECTION 4. Said chapter five hundred and forty-one is hereby further amended by inserting the following new section: — *Section 4.* Whoever permits the entrance or discharge into any part of the Neponset river or its tributaries of sewage or of any other substance injurious to public health or tending to create a public nuisance shall be punished by a fine not exceeding five hundred dollars for each offence. [*Approved May 7, 1906.*

Soon after the receipt of this notice most of the manufacturers on the river signified their intention of introducing methods of purifying the manufacturing wastes which now pollute the stream.

Nearly all of the pollution of the stream and its tributaries by sewage has now been discontinued, or the necessary changes to effect this result are now being carried out. Filter beds have been completed during the year for the purification of a part of the wastes from the tannery of the Winslow Brothers & Smith Company at Norwood, and the company is making preparations for the enlargement of these works to provide for the treatment of all of the wastes.

In some of the paper mills a great reduction has been made in the

quantity of water used and fouled in the various processes, which has resulted in a great reduction in the quantity of wash water requiring purification. Preparations for the early construction of purification works are being made at many of the factories.

One of the chief sources of pollution of the stream is the sewer of the town of Norwood, which discharges into the river above the Fowl Meadows. Plans for the purification of this sewage were prepared by the town some time ago; but, no steps having been taken toward the construction of the system, the Board, on Sept. 6, 1906, requested the Attorney-General to take action to prevent the further pollution of the stream from this sewer, and this matter is now in the hands of the court.

### *Pollution of Charles River.*

The construction of works for the collection and purification of the sewage of the town of Milford was begun early last summer, and the works had been partially completed at the end of the year. These works are designed to collect and purify all of the sewage of the town, and when completed will remove the serious nuisance which now exists in the Charles River below the town.

Plans have also been prepared for the collection and purification of the sewage of the town of Franklin, which now pollutes very seriously the waters of Mine Brook, one of the principal tributaries of the Charles River.

### *Shellfish in Boston Harbor.*

Late in the year, as a result of its investigations relative to the character of the water of Boston harbor and the shellfish taken from the flats therein, the Board, acting under the provisions of chapter 91, section 113, of the Revised Laws, requested the Fish and Game Commissioners to prohibit the taking of shellfish in "Boston harbor, including the tributaries of the Charles, Mystic and Neponset rivers, the Chelsea River and Dorchester and Quincy bays, inside, or west, of a line drawn from Nut Island to Prince's Head; thence along the bar from Prince's Head to Peddocks Island and through Peddocks Island to the northeasterly end thereof; thence to the southeasterly point of Deer Island and through Deer Island and across Shirley Gut to Point Shirley, excepting along the Winthrop shore inside, or northeast, of a line drawn from the outer end of the steamboat landing of the Point Shirley Club at Point Shirley to the outer end of the Cottage Park Yacht Club wharf on the southerly shore of Winthrop between Orlando and Woodside avenues; and to prohibit also the taking of any such shellfish about the shores of Lovells, Gallups and Georges islands, until you receive further notice from this Board."

## Local Epidemics.

During the period covered by this report, the assistance of the Board was requested by a number of local authorities in determining the cause of outbreaks of infective diseases, principally of typhoid fever. The results of the Board's investigations are presented in the Supplement.

## Food and Drug Inspection.

In this department of the Board's work which was begun in 1882, no changes in methods followed in the collection and examination of samples and in the enforcement of the laws have been made. The number of samples collected and examined during the fourteen months ended Nov. 30, 1906, was 7,530, and the total number since the work was begun has now reached 170,990.

During the period covered by this report, 409 prosecutions were brought in the various courts of the Commonwealth, bringing the total number to 2,510. The details are presented in the Supplement.

## Proprietary Medicines.

The Legislature of 1906 passed the following act:—

### Chapter 386, Acts of 1906.

### An Act relative to the Labelling of Certain Patent or Proprietary Drugs and Foods.

*Be it enacted, etc., as follows:*

Section 1. Upon every package, bottle or other receptacle holding any proprietary or patent medicine, or any proprietary or patent food preparation, which contains alcohol to an amount in excess of the amount shown to be necessary by the United States Pharmacopœia or the National Formulary as a solvent or preservative of the active constituents of the drugs contained therein, shall be marked or inscribed a statement of the percentage of alcohol by volume contained therein; and the provisions of section nineteen of chapter seventy-five of the Revised Laws shall apply to the manner and form in which such statements shall be marked or inscribed.

Section 2. Every package, bottle or other receptacle holding any proprietary or patent medicine or any proprietary or patent food preparation shall bear a label containing a statement of the quantity of any opium, morphine, heroin or chloral-hydrate contained therein, provided that the package contains more than two grains of opium, or more than one-fourth grain of morphine, or more than one sixteenth grain of heroin, or more than eight grains of chloral-hydrate in one fluid ounce, or, if a solid preparation, in one avoirdupois ounce; and the provisions of section nineteen of chapter seventy-

five of the Revised Laws shall apply to the manner and form in which such statements shall be marked or inscribed.

SECTION 3. It shall be unlawful for any person to sell, or to expose or offer for sale, or give or exchange, any patent or proprietary medicine or article containing cocaine or any of its salts, or alpha or beta eucaine or any synthetic substitute of the aforesaid.

SECTION 4. It shall be unlawful for any person to sell, or to expose or offer for sale, or to give or exchange any cocaine or alpha or beta eucaine or any synthetic substitute of the aforesaid, or any preparation containing the same, or any salts or compounds thereof, except upon the written prescription of a physician, dentist or veterinary surgeon registered under the laws of the Commonwealth; the original of which prescription shall be retained by the druggist filling the same and shall not again be filled.

SECTION 5. The provisions of sections three and four shall not apply to sales at wholesale made to retail druggists or dental depots nor to sales made to physicians, dentists or regularly incorporated hospitals.

SECTION 6. Whoever manufactures, sells or offers for sale any medicine or food preparation in violation of the provisions of this act shall be punished by a fine of not less than five nor more than one hundred dollars. It shall be the duty of the state board of health to cause the prosecution of all persons violating the provisions of this act; but no prosecutions shall be brought for the sale at retail, or for the gift or exchange of any patent or proprietary medicine or food preparation containing any drug or preparation the sale of which is prohibited or restricted as aforesaid, unless the said board has, prior to such sale, gift or exchange, given public notice in such trade journals or newspapers as it may select that the gift, exchange or sale at retail of the said medicine or food preparation would be contrary to law.

SECTION 7. This act shall take effect on the first day of September in the year nineteen hundred and six. [*Approved May 11, 1906.*

Under this act, which took effect on Sept. 1, 1906, during the three months ended Nov. 30, 1906, the following preparations were duly advertised: —

Crown Catarrh Powder. Crown Pharmacal Company, New York.

Dr. Agnew's Catarrhal Powder. Anglo-American Medicine Company, Chicago, Toronto and London.

Instant Cold Relief, Instant Catarrh Relief. I. C. R. Medicine Company, 168 Massachusetts Avenue, Boston.

Dr. Cole's Catarrh Cure. The Cole Medicine Company, London, New York, Chicago.

Pretzinger's Catarrh Balsam. R. Pretzinger & Bro., Dayton, O.

The Allenbury's Throat Pastilles, No. 9. Allen & Hanbury, Ltd., London.

Specific for asthma, hay fever and all catarrhal diseases of the respiratory organs. Nathan Tucker, M.D., Mount Gilead, O.

The result of the advertisements, of the wide notice given thereto by trade journals and circulars issued by wholesale houses, and of six prosecutions for the sale of the preparations after advertisement, was the practical disappearance of the latter from retail sale. The phraseology of section 1 of the act has proved to be an obstacle to the enforcement of its provisions.

### Inspection of Liquors.

The duties of the office of inspector and assayer of liquors, abolished in 1902, which were transferred to the Board in the same year, have been duly performed, and the work in connection therewith is reported upon in the Supplement.

### Inspection of Dairies.

The work of inspecting the sources of public milk supply, which was begun on March 1, 1905, has been continued on the lines originally adopted. During the past fourteen months 3,421 dairies have been visited by the veterinarian of the Board. Of this number, 154 lie beyond the borders of the State, but their product at the time when they were visited was sold wholly within the city of Springfield. The conditions observed in the very great majority of this group (only 16 of the 154 were reasonably clean) were almost incredibly bad, and the local authorities of Springfield acted with commendable promptness in excluding from sale the milk sent by those who failed to adopt the suggestions relative to necessary sanitary improvement conveyed to them in communications from the office of the Board.

Of the total number visited, somewhat less than a third were found to be free from objectionable features; but to the proprietors of 2,357, letters were sent calling attention to a total of 8,822 objectionable features, susceptible of correction either at no expense whatever or without unreasonable outlay. The details of this work will be found in the Supplement.

### Routine Work of the Board.

*Statistical Table for the 14 Months ended Nov. 30, 1906.*

| | |
|---|---|
| Whole number of samples of food and drugs examined during the fourteen months, | 7,530 |
| Samples of milk examined (included in the foregoing), | 3,603 |
| Whole number of samples of food and drugs examined since beginning of work in 1883, | 170,990 |
| Whole number of samples of milk examined since beginning of work in 1883, | 94,071 |

| | |
|---|---|
| Number of prosecutions against offenders during the fourteen months, | 409 |
| Number of convictions during the fourteen months,[1] | 395 |
| Amount of fines imposed during the fourteen months, | $7,266 |
| Number of dairies examined, | 3,421 |
| Number of packages of antitoxin of 1,500 units each issued to cities and towns, | 70,424 |
| Number of tubes of vaccine issued to cities and towns, | 31,805 |
| Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns, | 4,133 |
| Number of examinations made for diagnosis of tuberculosis, | 1,576 |
| Number of examinations of blood made for diagnosis of malarial infection, | 21 |
| Number of examinations of blood made for the diagnosis of typhoid fever, | 820 |
| Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws, | 33,596 |

| | |
|---|---|
| Force employed in general work of Board at central office, State House: — | |
| Secretary, | 1 |
| Assistant to the secretary, | 1 |
| Clerks, | 5 |
| Messenger, | 1 |
| Sanitary inspector of dairies, | 1 |
| Total, | 9 |

| | |
|---|---|
| Force employed for food and drug inspection: — | |
| Chemists and assistants, | 4 |
| Inspectors, | 3 |
| Total, | 7 |

| | |
|---|---|
| Force employed at laboratory (Bussey Institution): — | |
| Pathologist, | 1 |
| Assistants, | 6 |
| Total, | 7 |

[1] 2 cases pending.

*Under the Provisions of Sections 112 to 118 of Chapter 75, Revised Laws.*

| | | |
|---|---|---|
| Applications for advice from cities, towns and others: — | | |
| Relating to water supply, | | 88 |
| Relating to ice supply, | | 6 |
| Relating to sewerage and drainage, | | 26 |
| Relating to pollution of streams, | | 4 |
| Miscellaneous, | | 6 |
| Total, | | 130 |
| Number of samples of water, ice and sewage examined chemically and microscopically at the laboratory, Room 502, State House, | | 5,536 |
| Number of samples of sewage, water and ice examined chemically and bacterially at the Lawrence Experiment Station, | | 3,123 |
| Number of samples of sand examined chemically at the Lawrence Experiment Station, | | 135 |
| Number of samples of sand examined mechanically at the Lawrence Experiment Station, | | 55 |
| Additional samples examined bacterially at the Lawrence Experiment Station, | | 4,400 |
| Samples of water, ice, etc., examined for bacteria, B. coli and sewage Streptococcus at the Lawrence Experiment Station, | | 5,023 |
| Total number of samples examined, | | 18,272 |
| Force employed at central office: — | | |
| Chief engineer, | 1 | |
| Assistant engineers, | 7 | |
| Stenographers and clerks, | 4 | |
| Messenger, | 1 | |
| | — | 13 |
| At laboratory, Room 502, State House: — | | |
| Chemist, | 1 | |
| Assistant chemists, | 6 | |
| Biologist, | 1 | |
| Stenographer, | 1 | |
| | — | 9 |
| At Lawrence Experiment Station: — | | |
| Assistant chemists, | 2 | |
| Bacteriologists, | 2 | |
| Other assistants and laborers, | 3 | |
| | — | 7 |
| Total ordinary force, | | 29 |

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

| | | | |
|---|---|---|---|
| 1886, | 8 | 1898, | 75 |
| 1887, | 22 | 1899, | 79 |
| 1888, | 28 | 1900, | 104 |
| 1889, | 38 | 1901, | 105 |
| 1890, | 23 | 1902, | 93 |
| 1891, | 53 | 1903, | 129 |
| 1892, | 56 | 1904, | 125 |
| 1893, | 51 | 1905, | 105 |
| 1894, | 53 | 1906, | 130 |
| 1895, | 52 | | |
| 1896, | 65 | Total, | 1,453 |
| 1897, | 59 | | |

APPROPRIATIONS.

The appropriations for three months of the year 1905 and eleven months of the year 1906, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

| | |
|---|---|
| For the general expenses of the Board, | $28,904 27 |
| For the inspection of food and drugs, | 15,357 28 |
| For the production and distribution of antitoxin and vaccine, | 13,068 09 |
| For the purity of inland waters, | 32,083 33 |
| For the examination of sewer outlets and Neponset River, | 8,250 00 |
| For printing the annual report, | 4,000 00 |
| Total, | $101,662 97 |

EXPENDITURES.

The expenditures in 1905 and 1906 under the different appropriations were as follows: —

*General Expenditures, from Oct. 1, 1905, to Nov. 30, 1906.*

| | |
|---|---|
| Appropriation, 1905, three months, October 1 to December 31, | $9,138 13 |
| Appropriation, 1906, eleven months, January 1 to November 30, | 19,766 14 |
| | $28,904 27 |

| | |
|---|---|
| Salaries, | $17,580 81 |
| Travelling expenses, | 3,270 88 |
| Stationery, | 518 81 |
| Printing, | 1,587 47 |
| Books, subscriptions and binding, | 701 76 |
| Advertising, | 62 27 |
| Express charges, | 48 55 |
| Extra services, | 1,340 85 |
| Messenger, | 134 29 |
| Postage and postal orders, | 1,372 46 |
| Telephone and telegraph messages, | 107 24 |
| Typewriting supplies, | 144 26 |
| Special investigations, | 645 95 |
| Sundry office supplies, | 1,118 10 |
| Laboratory supplies, | 218 57 |
| Miscellaneous, | 49 85 |
| Total, | $28,902 12 |

*Expenditures for the Production and Distribution of Antitoxin and Vaccine from Oct. 1, 1905, to Nov. 30, 1906.*

| | |
|---|---|
| Appropriation, 1905, three months, October 1 to December 31, | $3,901 43 |
| Appropriation, 1906, eleven months, January 1 to November 30, | 9,166 66 |
| | $13,068 09 |

| | |
|---|---|
| Salaries, | $5,682 44 |
| Printing, | 208 66 |
| Stationery, | 9 58 |
| Laboratory supplies, | 1,317 08 |
| Laboratory construction, | 304 38 |
| Rent of laboratory, | 1,250 00 |
| Express, | 22 23 |
| Travelling, | 12 96 |
| Purchase of animals, | 820 50 |
| Board of horses, | 2,305 28 |
| Services of veterinary, | 49 00 |
| Food for animals, | 302 86 |
| Rental of telephone, messages, and postage, | 204 60 |
| Extra services, | 65 48 |
| Ice, | 78 51 |
| Gas, electric lighting and heating, | 320 42 |
| Miscellaneous, | 113 41 |
| Total, | $13,067 39 |

*Expenditures under the Provisions of the Food and Drug Acts from Oct. 1, 1905, to Nov. 30, 1906.*

| | |
|---|---|
| Appropriation, 1905, three months, October 1 to December 31, | $3,898 95 |
| Appropriation, 1906, eleven months, January 1 to November 30, | 11,458 33 |
| | $15,357 28 |

| | |
|---|---|
| Salaries of analysts, | $6,377 95 |
| Salaries of inspectors, | 4,762 35 |
| Travelling expenses and purchase of samples, | 2,501 56 |
| Apparatus and chemicals, | 254 10 |
| Printing, | 12 65 |
| Services, cleaning laboratory, | 147 00 |
| Express and telegrams, | 5 88 |
| Sundry laboratory supplies, | 103 14 |
| Typewriting supplies and stationery, | 17 50 |
| Books, | 6 00 |
| Extra services, | 1,144 22 |
| Miscellaneous, | 8 75 |
| Total, | $15,341 10 |

*For carrying out the Provisions of the Act to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water Supply, Drainage and Sewerage.*

| | |
|---|---|
| Appropriation, eleven months, | $32,083 33 |

| | |
|---|---|
| Salaries, including wages of laborers at Lawrence Experiment Station, | $24,514 62 |
| Apparatus and materials, | 3,076 54 |
| Rent of Lawrence Experiment Station, | 150 00 |
| Use of tools and office, Lawrence Experiment Station, | 267 03 |
| Travelling expenses, | 1,239 70 |
| Express charges, | 920 88 |
| Books and binding, | 247 15 |
| Maps and blue prints, | 250 90 |
| Stationery, drawing materials and typewriting supplies, | 486 54 |
| Telephone and telegraph messages, and postage, | 41 34 |
| Extra services, | 534 71 |
| Services, collecting samples and reading gauges, | 6 00 |
| Miscellaneous, | 347 73 |
| Total, | $32,083 14 |

*For the Examination of Sewer Outlets, under the Provisions of Section 4 of Chapter 75 of the Revised Laws.*

| | |
|---|---|
| Appropriation, 11 months, | $8,250 00 |

| | |
|---|---|
| Salaries, including wages of laborers at Lawrence Experiment Station, | $6,687 00 |
| Apparatus and materials, | 253 30 |
| Use of tools and office, Lawrence Experiment Station, | 30 46 |
| Travelling expenses, | 1,066 58 |
| Express, | 23 17 |
| Telephone and telegraph messages and postage, | 52 56 |
| Extra services, | 18 49 |
| Books, maps and blue prints, | 33 72 |
| Stationery and drawing materials and typewriting supplies, | 22 47 |
| Miscellaneous, | 61 82 |
| Total, | $8,249 57 |

HENRY P. WALCOTT.
JULIAN A. MEAD.
HIRAM F. MILLS.
JOHN W. BARTOL.
GERARD C. TOBEY.
JAMES W. HULL.
CHARLES H. PORTER.

# SUPPLEMENT.

# WATER SUPPLY AND SEWERAGE.

## ADVICE TO CITIES, TOWNS AND PERSONS.

# ADVICE TO CITIES, TOWNS AND PERSONS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

> consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1906 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this act or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Amesbury.
Amesbury (Rocky Hill Spring Water Company).
Amherst.
Andover.
Ashland (wells at schoolhouses).
Avon.
Ayer.
Barnstable (Craigville Camp Meeting Association).
Belchertown.
Beverly (United Shoe Machinery Company).
Boston (Boston Belting Company).
Bridgewater and East Bridgewater.
Cambridge (well at Dunster Hall).

Chelmsford (North Chelmsford Fire District).
Chelmsford (well at schoolhouse).
Chicopee (two).
Dracut (Dracut Water Supply District).
Easthampton.
Edgartown.
Fall River.
Falmouth.
Foxborough (State Hospital).
Framingham (State camp ground) (two).
Franklin (two).
Franklin (well at schoolhouse).
Great Barrington (Monument Mills).
Hadley (Hadley Water Supply District).
Haverhill (Island Park Box Factory).
Holyoke.
Holyoke (well at schoolhouse).
Lawrence (Wood Worsted Mills).
Lincoln (two).
Lynn.
Lynn (spring near Sterling Street).
Lynn (springs).
Manchester.
Marblehead.
Marion (well near town hall).
Mattapoisett.
Maynard.
Medway (spring in West Medway).
Medway (wells at schoolhouses) (two).
Montague (Millers Falls Water Supply District).
Needham.
Newbury (Dummer Academy).
North Adams (City Farm).
Northampton (Holyoke Canoe Club).
Northampton (wells at Laurel Park).
Norton (two).
Norwood.
Oxford.
Palmer (Town Farm).
Pittsfield.
Plymouth.
Provincetown.
Rutland (Industrial Camp).
Salem and Beverly (two).
Sharon (three).
Southbridge.
South Hadley.
Spencer (E. Jones & Co.).
Springfield (three).
Springfield (Kibbe Bros. Company).
Stoughton (wells).
Swampscott (Moose Hill Spring).
Swampscott (E. B. Greenleaf).
Taunton.
Wakefield.
Waltham (Judson L. Thomson Manufacturing Company).
Wayland.
Wellesley (Wellesley College).
Westborough.
Westborough (Insane Hospital) (two).
West Bridgewater (Howard Seminary).
Westford.
Weston (Weston Athletic Association).
Weston (F. H. Hastings).
West Springfield.
Winchendon.
Woburn (A. Edward Roys).

### Ice Supply.

Framingham.
Medford.
Northampton.
South Hadley.
West Newbury.
Winchendon (Baxter D. Whitney & Son).

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Abington (Lewis A. Crossett Company).
Barnstable (State Normal School at Hyannis).
Beverly (two).
Canton (Massachusetts School and Home for Crippled and Deformed Children).
Cohasset.
Concord.
Concord (Massachusetts Reformatory).
Foxborough (State Hospital).
Franklin (two).
Haverhill.
Marion.
Milford.
Millbury.
Newburyport.
Northbridge.
Peabody.
Peabody (A. C. Lawrence Leather Company).
Revere.
Rockland (factories of Rice & Hutchins and J. W. Spence).
Rutland (Prison Camp and Hospital).
Taunton (two).
West Bridgewater (Howard Seminary).
Westfield.
Weymouth (Stetson Shoe Company).
Winchendon.

### Public Institutions.

Canton (Massachusetts School and Home for Crippled and Deformed Children).
Wrentham (new school for the feeble-minded).

## Water Supply.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to water supply: —

### Amesbury.

April 16, 1906.

*To the Board of Health of the Town of Amesbury.*

Gentlemen: — In accordance with your request for an examination of the water of the Market Street wells in Amesbury and of a brook flowing near the Market Street pumping station, from which water is said to have been admitted to the wells, the State Board of Health has caused the wells and brook to be examined by one of its engineers and samples of their waters to be analyzed.

The water-shed of the brook contains very few buildings, and the stream is not, apparently, being polluted at the present time by the direct discharge of sewage; but the results of an analysis of a sample of the water show that it contained a large number of bacteria, including, apparently, those characteristic of sewage. A considerable number of

bacteria was present also in the water being drawn from the wells, and a small number was found in the water from various taps in the town. These waters, judging from a preliminary examination, contained also bacteria characteristic of sewage.

It appears that the brook water had been admitted to the well and to the distributing system some time before the examination was made, and was probably the cause of the pollution of the water of the distributing system. If disease germs had been present in the brook water, it would have been impossible after the discovery was made to have prevented serious injury to the health of those using the water.

The Board would recommend that provision be made for preventing in the future any possibility of surface water entering any of the sources of water supply of the town.

During the past winter the Board investigated, at your request, the cause of several cases of typhoid fever believed to have been due to the introduction of water from the Powow River into the town water pipes. At the time the epidemic appeared, examinations of the water of the distributing system failed to show evidence of pollution. Information was submitted, however, showing that water had been pumped temporarily from the Powow River during a fire preceding this epidemic into a system of pipes separated from the town mains by a check valve, but whether any of this water entered the town mains or not could not be determined.

The Board would advise that all existing connections by which water from any other source than the wells from which your supply is drawn can be admitted to your supply mains be permanently shut off, and that no water be supplied to the town from any source unless the water has first been ascertained to be safe for drinking.

### AMESBURY (ROCKY HILL SPRING WATER COMPANY).

FEB. 1, 1906.

*To the Rocky Hill Spring Water Company,* MR. W. E. CARR, *Manager, Amesbury, Mass.*

GENTLEMEN: — In response to your application of Jan. 2, 1906, requesting an examination of the water of the Rocky Hill Spring, so-called, from which you state that you are selling water for drinking in Amesbury, Salisbury and other places, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water at this time was of good quality for drinking, though the quantity of organic matter and the number of bacteria were somewhat higher than are found in good spring waters. It is probable that if the basin at the spring should be lined with masonry instead of wood, carried up above the surface of the

ground so as to exclude surface water and were covered so as to exclude light, the excess of organic matter and bacteria would disappear. With these changes, this spring, while its surroundings remain as at present, would, in the opinion of the Board, be a safe source from which to take water for drinking.

### Amherst.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Jan. 4, 1906, for preventing the pollution and securing the sanitary protection of the waters of Amethyst Brook and its tributaries, used by the Amherst Water Company as a source of water supply for the town of Amherst.

### Andover.

July 5, 1906.

*To the Board of Public Works of the Town of Andover.*

Gentlemen: — In response to your request for an examination of Haggett's Pond in Andover, from which the water supply of the town is drawn, and advice as to the protection of the purity of its waters, the Board has caused the pond and its surroundings to be examined by one of its engineers.

The results of the examination show that the most evident danger to the purity of the water at the present time is the drainage from a building used as a restaurant, located upon the shore of the pond not far from the pumping station, wastes from which evidently at times enter the water. There appears to be no practicable way of preventing pollution of the pond from this building, unless it shall be moved back from the shore of the pond and a proper provision made for the disposal of the wastes in suitable cesspools, or in such other manner that polluting matters will not enter the pond.

There are numerous summer cottages along the shore of the pond and a picnic grove near its shore not far from the pumping station, and there are also several groups of farm buildings near one of the main feeders of the pond; but it did not appear that the pond was being polluted from any of these places at the time the examination was made.

It is advisable, in the opinion of the Board, that the use of the pond as a summer resort should be carefully regulated and the shore patrolled by inspectors, and such restrictions made as will prevent danger of pollution of the water; and the Board will, if you so request, establish rules and regulations for the sanitary protection of this source.

The Board would also again call attention to the possibility of taking water from the ground near the pond, instead of directly from the pond itself, and thereby avoid danger from pollutions entering the source of supply, as advised in its communication to your board on Sept. 5, 1901, a copy of which is enclosed herewith.

## Ashland (Wells at Schoolhouses).

Dec. 6, 1906.

*To the Board of Health of the Town of Ashland,* Mr. Frank A. Morse, *Chairman.*

Gentlemen: — In accordance with your request of November 27 for an examination of the wells used as sources of drinking water at three of the schoolhouses in Ashland, the water of which you state you have reason to believe is impure, the Board has caused the wells and their surroundings to be examined and samples of their waters to be analyzed.

The water of the well at the South school is very badly polluted and contains an excessive quantity of organic matter, and the Board would recommend that its further use be prevented. The waters of the wells at the Town Hall school and the high school are both seriously polluted, though not to such a degree as the water of the South school, and neither source can be regarded as safe for drinking.

## Avon.

June 7, 1906.

*To the Water Board of the Town of Avon,* Mr. John J. Collins, *Secretary.*

Gentlemen: — The State Board of Health has considered your application of May 9 for its opinion as to the advisability of allowing the grounds about the well and pumping station, from which the water supply of the town is drawn, to be used for pasturage, and has caused the locality to be examined by its engineer.

In the opinion of the Board, the use of the lands about the well in this way is objectionable, and should not be permitted.

## Ayer.

Feb. 1, 1906.

To Messrs. Frederick Whitney, William Brown and E. O. Proctor, *Water Commissioners of the Town of Ayer.*

Gentlemen: — The State Board of Health received from you on August 28 last an application requesting the advice of the Board with reference to a proposed additional water supply for the town, investigations for which were then being made. Subsequently, in accordance with your further request, the Board caused the various test wells in different parts of the town to be examined by its engineer and samples of their waters to be analyzed. Recently plans and a report have been submitted by your engineer which provide for taking an additional water supply from a proposed system of driven wells to be located along the southerly shore of the pond, west of your present pumping station and distant from 900 to 1,400 feet therefrom. It is proposed to draw water through a suction main 1,800 feet in length to the present pumping station, and

use the present works for pumping it to the town. On account of the very steep shore along this side of the pond, considerable excavation will be necessary in order to locate the wells at a considerable distance from the shore of the pond, and the plan submitted provides for locating the wells at least 50 feet from the shore.

The Board has caused an examination of the locality to be made by its engineer, and has considered the plan submitted and the results of the analyses of water from two test wells at the place where the new wells are to be located. These results indicate that the ground water of this locality is excellent for the purposes of a public water supply.

The territority on the northerly side of the pond opposite the wells is quite densely populated, but there are few houses within 1,000 feet of the wells. South of the pond there is an extensive sandy plain, which is uncultivated and uninhabited, with its surface at a considerable elevation above the pond. The indications are that the water which will enter the proposed wells will come chiefly from the southerly side of the pond and resemble the water of the test wells, and that it will not be affected materially by water filtering through the ground from the pond or from the north side, unless the quantity drawn should be greatly in excess of that required for the supply of Ayer.

While no thorough tests have been made to determine the probable quantity of water obtainable from the ground at the place where it is proposed to locate the wells, the soil penetrated by the test wells in this locality was found to be coarse and porous, and the wells yielded water very freely when pumping with a hand pump; and these indications, taken in connection with the results of the analyses, are favorable for obtaining an additional supply of good water for the town of Ayer from wells in this locality.

In the opinion of the Board, the plan, if carried out, is likely to furnish an additional supply of good water for the town at a reasonable cost.

On the plan submitted the wells are located quite closely together, in a line about 50 feet from the shore of the pond. It is desirable that the wells be located at greater distances from the shore, and it is probable that the amount of excavation necessary would not be materially increased, or the quantity of water obtainable materially diminished, by locating the wells in this line at greater distances apart and 75 feet or more from the shore of the pond; and the Board would advise that this change be made when the works shall be constructed.

## BARNSTABLE (CRAIGVILLE CAMP MEETING ASSOCIATION).

Nov. 1, 1906.

To CHARLES A. GROVES, M.D., *Chairman, Committee on Water Supply of the Craigville Camp Meeting Association, East Orange, N. J.*

DEAR SIR: — The State Board of Health has considered your application for advice as to a proposed water supply for about 65 cottages located in the village of Craigville in the town of Barnstable, the water to be taken from the ground on the westerly side of the main highway north of the village, and has caused the locality to be examined by one of its engineers and a sample of water from a test well recently driven in this locality to be analyzed.

The results of the analysis show the presence of considerable iron and organic matter, due probably to the fact that the well had not been pumped clear after driving. There appear to be no sources of pollution in the neighborhood of the well, and it is probable that an ample supply of good water for the village could be obtained from tubular wells in this neighborhood. It is advisable, however, that the wells be located somewhat farther from the pond than the test well from which the sample of water was collected for analysis. When you have put in additional wells the Board will, upon application, cause them to be examined, and will then give you further advice as to a water supply for the village.

## BELCHERTOWN.

MARCH 1, 1906.

*To the Board of Health of the Town of Belchertown,* Mr. NELSON RANDALL, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on January 31 an application for advice as to a proposed source of water supply for the town of Belchertown, to be taken from a well on the estate of M. P. Walker, and has caused the locality to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water, while nearly clear and colorless, is very hard, and has evidently at some time been polluted and not completely purified in its subsequent passage through the ground to the well. The well is located close to the village, and the quality of its water would be likely to deteriorate after long-continued use; and in the opinion of the Board this well is not a suitable source of public water supply.

Other sites for wells in this neighborhood have been indicated, but it is likely, in the opinion of the Board, that all waters drawn from the hill on which the village is located would be unfavorably affected by sewage or drainage therefrom.

The soil in the valley of Jabish Brook, both above and below the village, is apparently coarse and porous, judging from surface indications, and it is probable that a sufficient quantity of good water for the supply of the village could be obtained from the ground by means of wells or other works at some point in this valley; and the Board would advise that you cause a further investigation to be made of possible sources of water supply in the neighborhood of the village, with the assistance of an engineer of experience in such matters. The Board will assist you in the investigations by making the necessary analyses of the water, and will give you further advice when you have the results of further investigations to present.

### Beverly (United Shoe Machinery Company).

Dec. 6, 1906.

*To the United Shoe Machinery Company, Boston, Mass.*

Gentlemen: — The State Board of Health received from you on October 6, 1906, a communication stating that you had recently driven a well at your works in Beverly for the purpose of supplying drinking water to 3,000 employees in your factory there, and requesting advice as to the quality of the water. Subsequently six test wells were driven on land northwest of and not far from the factory, near Bass River, and a pumping test was made by pumping from the wells for a period of about six days at a rate of about 65,000 gallons per day.

A sample of water was collected from one of the wells on October 16, and six samples were collected during the pumping test.

The results of the analyses show that the water in the first days of the test was decidedly turbid and contained an excessive quantity of iron. The water was also very hard, but showed no evidence of sewage pollution. Toward the end of the test the turbidity and the quantity of iron present decreased considerably, though the quantity of the latter remained somewhat larger than is found in good ground waters. The hardness also decreased slightly, but there was a decided increase in the amount of free ammonia throughout the test.

The results of the analyses show that, while the water of these wells, in the condition in which it was found toward the end of this test, would probably be safe for drinking, it is an undesirable drinking water, on account of its hardness; and the increase in the free ammonia and the presence of a considerable quantity of iron indicate that the water may become objectionable after continued use, on account of an excessive quantity of iron and the disagreeable taste and odor which usually accompany it.

Under the circumstances, the Board cannot recommend the use of

these wells as a source of drinking water supply for your factory; but its use in its present condition would probably not be harmful, and an examination of the water after it has been drawn from the wells for a time would give more definite information in regard to its character.

## Boston (Boston Belting Company).

Dec. 18, 1906.

*To the Boston Belting Company, Boston, Mass.,* Mr. James B. Forsyth, *General Manager.*

Gentlemen:—In accordance with your request of Nov. 6, 1906, for an examination of the water of a well in your mill yard and advice as to its quality, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water entering this well has at some time been polluted, but subsequently well purified in passing through the ground to the well; and, in the condition in which it was found at the time the examination was made, the water is safe for drinking. The water is quite hard, and on this account is not a desirable drinking water; and if it is to be used it should be examined from time to time, in order that any deterioration in its quality may be detected and its further use prevented.

## Bridgewater and East Bridgewater.

May 3, 1906.

*To the Bridgewaters Water Company,* Mr. Joseph Weeks, *Treasurer.*

Gentlemen:—In accordance with your request for an examination of a deep tubular well near your works at Bridgewater, from which you propose to take water for the supply of the town, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water contains an excessive quantity of iron, making it objectionable for many of the purposes of a public water supply.

Regarding the quantity of water obtainable from the well no definite estimate can be given; but its location is such that its yield would be unlikely to add materially in any case to the quantity of water available for the supply of the towns of Bridgewater and East Bridgewater.

In a communication addressed to you May 4, 1905, the Board advised as follows:—

The quantity of water which the Bridgewaters Water Company is capable of supplying from its present sources is evidently inadequate for the requirements of the towns of Bridgewater and East Bridgewater. An additional supply should be provided with as little delay as possible, since it has

already been necessary, the Board is informed, to use water directly from the Town River, greatly jeopardizing the health of the people of these towns.

The Board would recommend that you employ an engineer of experience in matters relating to water supply, to make investigations and prepare plans for securing a sufficient additional quantity of good water to meet all the requirements of the towns now supplied from your works. The Board will assist you in these investigations, if you so request, by making the necessary analyses of water, and will give you further advice when the results of investigations are available.

The Board would again urge that you employ an engineer of experience in matters relating to water supply to make investigations and prepare plans for securing a sufficient additional supply of good water, to meet all the requirements of the villages of Bridgewater and East Bridgewater.

### CAMBRIDGE (WELL AT DUNSTER HALL).

JULY 5, 1906.

To Messrs. LEAVITT & PEIRCE, *Cambridge, Mass.*

GENTLEMEN:—In response to your request for an examination of a well at Dunster Hall in Cambridge, from which it is proposed to take water for drinking, an examination of the source has been made and samples of the water analyzed.

The results of the analyses show that the water is turbid and contains more organic matter than is found in a good ground water. It is also very hard and contains an excessive amount of iron; and, in the opinion of the Board, this water is unfit for drinking or cooking.

### CHELMSFORD (NORTH CHELMSFORD FIRE DISTRICT).

AUG. 2, 1906.

*To the Board of Water Commissioners of the North Chelmsford Fire District,* MR. JAMES P. DUNIGAN, *Chairman.*

GENTLEMEN:—The State Board of Health received from you on July 27, 1906, the following application requesting approval by this Board of the use of water from a system of tubular wells located at the foot of Washington Street near the easterly shore of Newfield Pond, or Crystal Lake, so called:—

Under . . . an act of Massachusetts Legislature of 1906 a "fire district" has been established in North Chelmsford, for the purpose of obtaining a water supply. This act has been accepted by the voters of the fire district, and driven wells have been located near Newfield Pond and samples of water sent to you for analysis. Will you further assist us in approving of water and location of wells according to such act?

A plan of location of wells accompanies this application.

The application was accompanied by a plan entitled: "North Chelmsford Water Supply. Plan showing Land taken and Location of Driven Wells. Scale 50 feet to an inch. Lowell, Mass., July 25, 1906. Smith and Brooks, Civil Engineers."

The Board has considered the application and the plan submitted therewith, and has caused the locality to be examined by its engineer and samples of water collected from the test wells during a short pumping test to be analyzed.

The results of the analyses show that the water pumped from the wells at this time was of good quality for the purposes of a public water supply. If water should be pumped continually from the ground in this region, in a quantity such as would be required for the supply of North Chelmsford, it is probable that the ground water would flow to the wells from a much greater distance than was the case during the test referred to; and the quality of the water would undoubtedly be affected unfavorably by the sewage and other wastes discharged upon or into the ground from the dwelling houses already constructed in the neighborhood of the pond in this region. The acquirement by the fire district of the lands indicated as already acquired on the plan submitted will, if the houses already built are vacated and not used in future, remove some of the sources of pollution; but there is danger that the region farther back may become densely populated within a few years, and affect unfavorably the quality of the water of the wells.

In the opinion of the Board, in order to properly protect your sources of supply, if these wells should be used, it will be necessary for the fire district to acquire a larger area of land, and possibly also to provide sewerage for territory farther back.

While it is possible to so protect the source now proposed that the water will continue to be of good quality, the cost of adequate protection is likely to add greatly to the cost of the works; and it is important, in the opinion of the Board, to determine whether it is possible to secure a supply of good water in some other locality at less expense.

The conditions are apparently favorable for obtaining water freely from the ground at several places near the village. A few tests have been made near Newfield Pond, about 800 feet north of the present wells, but the results were not satisfactory. The conditions there, however, appear to be quite favorable for obtaining water freely from the ground, and the Board would recommend that you make further tests in that locality. If it is found impracticable to obtain a supply of good water in that locality, investigations should be made at some of the other places where the conditions appear to be favorable for obtaining an adequate supply of good water.

The Board will assist you in these investigations by making the necessary analyses of samples of water, and will give you further advice when the results of further tests are available.

### CHELMSFORD (WELL AT SCHOOLHOUSE).

APRIL 5, 1906.

*To the School Committee, Chelmsford, Mass.*

GENTLEMEN: — In response to your request for an examination of the water of a well at the school at Chelmsford Centre, used by the children for drinking, the Board has caused the well to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water has at some time been considerably polluted and not thoroughly purified before entering the well, and, in the opinion of the Board, the source cannot be regarded as a safe one from which to take water for drinking. The Board would recommend that the use of this well be discontinued, and a supply of water obtained from some source the water of which is known to be safe for drinking.

### CHICOPEE.

SEPT. 6, 1906.

*To the Board of Water Commissioners of the City of Chicopee, Mr. O. A. BOGARDUS, Superintendent.*

GENTLEMEN: — The State Board of Health received from you on Aug. 4, 1906, a communication requesting the advice of the Board as to protecting the purity of the water of Abbe Reservoir, so called, in Springfield, — one of the sources of supply of the city of Chicopee, — containing the following statement as to certain objectionable conditions which now exist in the neighborhood of one of the feeders of this reservoir: —

> At the source of one of the brooks which supplies the "Abbey Reservoir," a part of the public water supply of Chicopee, is a dwelling, a barn with two cows, one horse, a henhouse with thirty-five hens and a privy with no vault. These buildings are all on a steep slope draining towards and within 35 feet of the brook. The house is on St. James Avenue, Springfield, beyond Carew Street; the premises are owned by the estate of A. W. Lincoln and occupied by Peter Landry.

In response to this application, the Board has caused the locality to be examined by one of its engineers and has considered the information presented.

There is no doubt that there is serious danger of the pollution of the Abbe Reservoir by sewage from these buildings at the present time; but, by providing a suitable vault or cesspool for the reception of the

house sewage and making such changes in structures as may be necessary, and by establishing and enforcing sanitary rules and regulations, adequate protection of the purity of this source can be secured. The buildings are so located, however, that frequent inspection will be necessary to prevent the pollution of your water supply therefrom; and the Board would recommend that the city secure control of them, and discontinue their use as soon as practicable.

It is desirable that sanitary rules and regulations be adopted and enforced not only in the water-shed of Abbe Reservoir but in the water-sheds of your other sources of supply; and the Board will make suitable rules and regulations for the protection of these sources, under the provisions of chapter 75, section 113, of the Revised Laws, if you so request.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Nov. 1, 1906, for preventing the pollution and securing the sanitary protection of the waters of Morton Brook, Cooley Brook, Abbe Reservoir and their tributaries, used by the city of Chicopee as sources of water supply.

### Dracut (Dracut Water Supply District).

**Feb. 27, 1906.**

*To the Water Supply Committee of the Dracut Water Supply District.*

Gentlemen: — In response to your application for advice as to taking water for the supply of the Dracut Water Supply District from wells in the Goodhue Meadow, the State Board of Health has caused a further examination of the locality to be made by its engineer and has considered the results of a test of the probable quantity and quality of water obtainable from the ground in this region, made by pumping continuously from a group of wells in this meadow for a period of ten days, ending on Jan. 19, 1906. During this test a record was kept of the quantity of water pumped, and observations were made of the variations in the height of water in two of the test wells and in other wells near the meadow.

The records show that the quantity pumped averaged 225,000 gallons per day, and that the level of the ground water in the vicinity of the test wells, which went down rapidly at first and then more slowly, finally remained practically constant during the last days of the test, indicating that, under the conditions then existing, the wells would probably continue to yield the quantity of water then being drawn. The tests were made in dry weather for the winter season, but in a dry summer it is probable that the yield of the wells would be much smaller than during this test. It is likely, however, in the opinion of the Board,

that enough water can be obtained from this source for the present requirements of the water supply district if the water works shall be well constructed and the water distributed in an economical manner; and it appears to be possible to increase the supply by extending the collecting works to other parts of the valley.

The water pumped from the wells during the test, as shown by daily analyses, was clear, practically colorless and odorless, and of good quality for domestic purposes. The quantity of iron present was slightly larger than is found in some ground waters, but did not show a tendency to increase during the test. The meadow in which the wells are located is covered with peaty soil to a depth of 3 or 4 feet; and water from wells in such localities often deteriorates after a longer or shorter period of use, and becomes affected by the presence of an excessive quantity of iron, which makes it objectionable for some domestic purposes. It is uncertain that such deterioration will not occur in this case; but it would be less likely to occur if the wells should be spread out over a considerable area, and might be avoided if it should occur by locating the wells near the edge of the meadow instead of near the middle, where the present test wells are located. In any case, it is probable that if deterioration should occur the water could be purified by filtration at no great extra cost.

It does not appear to the Board, from the results presented of a general examination of other possible sources of supply near the village, that there is any source within a reasonable distance that is likely to furnish a sufficient quantity of water of as good quality as that which seems likely to be obtained from wells in the Goodhue Meadow; and, in the opinion of the Board, the source appears to be the most appropriate source of water supply for the district to adopt.

There are three or four dwelling houses on the upland near the westerly side of the meadow not very far from the wells, the sewage and wastes from which are now discharged upon or into the ground in the neighborhood of the buildings. Provision should be made for disposing of the sewage from these houses in such a way that it will not injure the quality of the well water.

## EASTHAMPTON.

MARCH 1, 1906.

*To the Easthampton Water Board, Easthampton, Mass.*

GENTLEMEN: — The State Board of Health received from you on Feb. 23, 1906, the following communication, requesting its advice as to the effect upon the public health of constructing a reservoir on Bassett Brook: —

The Easthampton water board wishes to know if the flooding of about 40 acres of land directly back of West Street on the Bassett farm, to be used for power purposes, will in any way affect the health of the neighborhood.

At West Street there is a dam that only needs a gate to hold the water back; and it is said by some people that the raising and lowering of the water in the pond, according to the quantity used, would make it unhealthy. We wish to use your reply, if necessary, in our report to the coming town meeting, — that is, if your report is favorable to the plan. If not, we will not recommend it, and, as we meet early in March, an early reply will greatly oblige. . . .

In response to this application, the Board has caused the locality to be examined by one of its engineers and has considered the information presented.

It appears that the proposed reservoir would have an area of nearly 40 acres and a maximum depth of about 10 feet, with steep banks. The area to be flowed contains a few bushes and trees, but is in the main cleared land, containing little swamp or meadow.

Since the water of the reservoir is to be used for the purpose of increasing the power on the Manhan River in dry weather, the reservoir will doubtless be drawn down at times in hot weather, and a considerable area of its bottom exposed. Under these conditions there will doubtless be some odor from it at times, as there is from most such reservoirs when the bottom is exposed in summer. It is possible also that algæ of certain kinds may grow in abundance in the waters of this reservoir, and in their decay give off offensive odors. These conditions are likely to be more objectionable, since practically all of the water of the brook above the proposed reservoir is used during the summer for the supply of the town, and there will be little or no water flowing into the reservoir in dry weather. The size and the steepness of the banks of the reservoir are such that it is unlikely to become a breeding place for mosquitoes, which cause the spread of malaria, unless drawn so low as to leave a shallow pool for a period of several days; and objectionable conditions resulting from the building of this reservoir and using it as proposed are likely, in the opinion of the Board, to be confined to objectionable odors from the causes mentioned.

The reservoir is obviously not adapted for the storage of water to be used for domestic water supply, and it is understood that it is not to be so used.

## EDGARTOWN.

MAY 8, 1906.

*To the Edgartown Water Company,* WILLIAM M. BUTLER, Esq., *President.*

GENTLEMEN: — The State Board of Health received from you on April 10, 1906, the following application, requesting approval by the State Board of Health of the location of certain proposed wells for collecting water for the supply of the village of Edgartown, and the consent of the Board to the purchase or taking of certain lands for preserving the quality of the water: —

Acting under the provisions of chapter 143 of the Acts of the Legislature of 1906, application is hereby made to your Board for its consent to purchase or take land at "Wintucket Bottom," so called, at Edgartown, Mass., for purposes of a water supply for the inhabitants of said town of Edgartown.

A description of said land accompanies this application, and also a plan showing the land described, entitled, "Edgartown, Mass., Water Works. Plan of Wintucket Bottom and land of Susan R. Beetle; showing also location of test wells and proposed supply wells. Scale 100 feet to 1 inch," dated April, 1906, and from the office of Louis E. Hawes, civil and hydraulic engineer, Boston, Mass.

Application is also hereby made for your approval of the location of the proposed supply wells or well for collecting the water, where shown on the plan above mentioned at the location of test well No. 2, and storage of the water in a covered stand-pipe on Mill Hill near the village of Edgartown.

In response to this application, the Board has caused the locality to be examined by one of its engineers and has considered the plans and report submitted, and the results of analyses of samples of water from test wells in this locality collected and sent to the laboratory of the Board by your engineer.

The results of these analyses are much the same as the results of similar examinations of waters from test wells in this locality made several years ago, and indicate that the ground water in the region is of excellent quality for all the purposes of a public water supply.

The soil about the Wintucket Bottom in which the wells are located is evidently coarse and porous, and the test wells show that the porous soil extends to a considerable depth.

The location of the proposed wells appears to be a satisfactory one, and there is very little doubt that a satisfactory supply of water for Edgartown can be obtained from the ground in this region; but the Board would advise that when the wells from which it is proposed to

draw the supply have been installed and connected with the pumps a test be made by pumping from them for a short time, and that samples of the water be analyzed, so that the probable yield and quality of the water of the wells may be definitely determined, and changes in the system made if found necessary.

The region about the wells is at present uninhabited, and the area of land which it is proposed to purchase or take, as shown upon the plan submitted, for the protection of the supply will furnish all the protection that appears to be necessary at the present time.

The Board hereby consents to the taking of the lands indicated, and approves the general location of the proposed wells, as shown upon the plan submitted, entitled: "Edgartown, Mass., Water Works. Plan of Wintucket Bottom and land of Susan R. Beetle; showing also location of test wells and proposed supply wells. Scale, 100 feet to an inch. April, 1906. From the office of Louis E. Hawes, civil and hydraulic engineer, Boston, Mass."

### Fall River.

Sept. 6, 1906.

To the Hon. John T. Coughlin, *Mayor of the City of Fall River.*

Dear Sir: — A petition having been received from certain residents on Tower Street in the city of Fall River, relative to the necessity of the extension of the city water supply to that street for the use of the inhabitants living thereon, the Board has caused the locality to be examined by one of its engineers and samples of the well waters used in the dwelling houses on that street to be analyzed.

The results of the analyses show that these waters are very badly polluted, and they are likely to injure the health of those who use them for drinking.

There appears to be no practicable way by which the residents in this locality can obtain an adequate supply of good water for domestic uses unless the city pipes shall be extended to this region; and, in the opinion of the Board, it is advisable, in the interests of the health of the city, that the city water supply be extended to these dwellings as soon as practicable.

### Falmouth.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on March 8, 1906, for preventing the pollution and securing the sanitary protection of the waters of Long Pond and its tributaries, used by the town of Falmouth as a source of water supply.

### Foxborough (State Hospital).

[See reply of Board on page 158.]

### FRAMINGHAM (STATE CAMP GROUND).

MAY 22, 1906.

To Capt. CHRISTOPHER HARRISON, *Engineer Officer Staff Brigade*, and JOHN M. LITTLE, Jr., *First Lieutenant and Assistant Surgeon, Field Battery A.*

GENTLEMEN: — In response to your recent request for copies of the latest analyses of the water supplied to South Framingham, and the opinion of the Board as to the desirability of its use for the troops at the camp ground, the Board has caused an inspection to be made of the filter-gallery from which the supply is drawn, has examined the results of analyses of the water, and encloses herewith the results of the most recent analysis.

The filter-gallery is situated close to Farm Pond, near the northerly part of the village of South Framingham, and derives its waters in part by filtration through the ground from the pond and in part from the rainfall on the porous ground about it, which sinks into the soil and percolates through it to the filter-gallery.

Farm Pond appears to receive but little direct pollution, and at the present time the water entering the filter-gallery from this source is probably safe for drinking. The water derived from the land side is evidently affected by pollutions discharged upon or into the ground in the vicinity; but the nearest of these possible sources of pollution is distant more than 400 feet from the filter-gallery, so that the polluted water entering the gallery from these places must pass for a long distance through the ground, and is likely to be thoroughly purified.

The quality of the water supplied from the filter-gallery has deteriorated, especially in the past two years, as shown by the increase in organic matter and in chlorine. This increase is probably due to the proximity of three houses not connected with a sewer and to a camp of laborers within 450 feet from the filter-gallery; and, if these sources of probable pollution are not immediately removed, the Board would advise obtaining water from a more reliable source.

JULY 5, 1906.

To Dr. WILLIAM H. DEVINE, *Surgeon General, Massachusetts.*

DEAR SIR: — In response to your communication received June 23, 1906, stating that the next encampment at South Framingham will take place on July 7, and requesting that an analysis of the water supply there be made in the mean time, the State Board of Health has caused a further examination of the source of supply of the Framingham Water Company to be made by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that no material change has taken place recently in the quality of the water; and an examination of the

surroundings of the filter-gallery from which the supply is drawn shows that the objectionable conditions referred to in the communication of the Board on May 22 have not been improved.

## Franklin.

May 8, 1906.

*To the Franklin Water Company, Franklin, Mass.*

Gentlemen: — The State Board of Health received from you on April 26, 1906, an application for advice with reference to a proposed water supply for Franklin, containing the following outline of your proposed plans: —

We propose to derive a sufficient supply of water from a system of 2½-inch or 3-inch driven wells, situated on a triangular piece of land adjacent to and west of Beaver Pond, and bounded by Beaver Pond, Mine Brook and Beaver Street, said wells to be in the immediate vicinity of test wells already driven, and from which good, pure water is obtained.

These test wells show the formation of the soil to be clean white sand to a depth of 20 feet, a layer of gravel from 20 feet to 30 feet, underlaid with another stratum of fine sand to bed rock, which occurs at a depth of 40 to 50 feet.

It is proposed to sink these wells into the layer of gravel at an average depth of 30 feet, and equip them with Smith strainers to exclude the sand; the wells to be connected up and entered into a 12-inch main which connects with the pumps.

The Board has considered the plan presented, and has caused the locality to be examined by its engineer and samples of the water of the test wells to be analyzed.

The results of the analyses indicate that the water at this place is of good quality for the purposes of a public water supply, and the conditions appear to be favorable for obtaining a large quantity of water from the ground in this region.

The Board would recommend, as the next step in your investigations, that you cause additional wells to be put in at this place, and a pumping test to be made by pumping from the wells with a steam pump at a rate of at least 300,000 gallons a day for a period of about ten days, in order to determine more definitely the probable quantity of water obtainable from the ground in this region, and its probable quality. The Board will assist you in these investigations by making the necessary analyses of the water, and will give you further advice when the results of further tests are available.

Nov. 7, 1906.

*To the Franklin Water Company, Franklin, Mass.*

GENTLEMEN: — The State Board of Health received from you on Oct. 25, 1906, the following application for advice as to the use of water taken from wells northwest of Beaver Pond for the supply of the town of Franklin: —

We have recently submitted samples of water taken from the 2-inch driven wells situated on the north side of Beaver Pond, and it is our intention, if the water is suitable, to supply it to the town of Franklin. We herein enclose a sketch showing the location of wells, pumping station and connections. We have heretofore taken water direct from Beaver Pond through a 12-inch cast-iron suction main, laid in August, 1904, as shown on the sketch by the red line. We have now inserted a 12-inch "Y," put in two 12-inch gates, and carried the 12-inch cast-iron pipe line 600 feet along the shore of the pond, to a point within 150 feet of the wells. When a sufficient number of wells has been driven to furnish 600,000 gallons per day, we wish to connect said 12-inch pipe with said wells and draw water therefrom, closing the gates between the "Y" and the pond, and discontinue the use of the water from the pond except in case of fire or accident.

We submit these plans for your consideration, and ask your advice concerning the same.

The Board has caused the locality to be examined by its engineer and samples of water collected from the test wells during a pumping test from October 9 to October 13 to be analyzed.

The results of the analyses show that the water drawn from the wells is of good quality for water-supply purposes. The information submitted to the Board shows that the quantity of water pumped during the test amounted to somewhat more than 400,000 gallons per day, and that the water in test wells in the neighborhood was not materially lowered while the pumping continued, indicating that a sufficient supply of water for the present requirements of Franklin can be obtained from the ground at this place.

According to the plan submitted, it is proposed to pump the water from the new wells with the pumps located in the present pumping station by extending a branch from the present suction pipe, which runs into Beaver Pond, to the new wells. The suction pipe passes beneath Mine Brook and the marshes adjacent thereto, which are flooded by the polluted water of the brook; and, if leakage should occur at any point in this pipe line, the polluted water of Mine Brook would enter the supply.

It also appears to be the intention to retain a connection with Beaver Pond, so that that source may be used. In the opinion of the Board, this arrangement is not a desirable one; and the Board would recommend

that the location of the pumping station be changed to the neighborhood of the new wells, and that the pipe crossing the meadows and under Mine Brook be used as a force main, so that there will be no danger of the pollution of the water supply from this cause, and that the use of water from Beaver Pond be permanently discontinued.

## FRANKLIN (WELL AT SCHOOLHOUSE).

OCT. 4, 1906.

*To the Board of Health of the Town of Franklin,* G. A. MARTIN, M.D., *Chairman.*

GENTLEMEN: — In response to your request of Sept. 10, 1906, for an examination of the water of a well in the Nason Street school yard, and advice as to its quality, the Board has caused an examination of the well to be made and a sample of the water to be anlyzed.

The results of the analysis show that the water has been considerably polluted, and contains a much larger quantity of organic matter than is found in good well waters; and, in the opinion of the Board, the water of this well cannot be regarded as safe for drinking.

## GREAT BARRINGTON (MONUMENT MILLS).

APRIL 5, 1906.

Mr. T. ELLIS RAMSDELL, *Agent, Monument Mills, Housatonic, Mass.*

DEAR SIR: — In response to your request of Feb. 19, 1906, for an examination of the water of a deep tubular well on the premises of the Monument Mills near the Housatonic River in Great Barrington, and advice as to its quality, the Board has caused the locality to be examined by one of its engineers and a sample of the water to be analyzed.

From the information submitted to the Board it appears that the well in question is a flowing tubular well, 8 inches in diameter and about 503 feet in depth, located on an island in the river. A sewer passes within a few feet of the well, and there are several vaults and cesspools at no great distance, but at a lower level than the sources from which the water at present comes.

The results of an analysis of the water show that, while it is somewhat hard, it is clear, colorless and odorless, and has the general characteristics of an unpolluted ground water of this region; and in the state in which it was found at this time the water is safe for drinking.

It is possible that the quality of the water may be somewhat different at other seasons of the year, but there is no indication that the water would be objectionable. If, however, the well should be connected directly with a pump and the level of the water lowered, a material change might take place in its quality; and if water is to be drawn from the well in this way, it should not be used for drinking until it has been analyzed and its safety for such use ascertained.

### HADLEY (HADLEY WATER SUPPLY DISTRICT).

APRIL 5, 1906.

To Messrs. F. H. SMITH, A. W. HURD and E. J. ALDRICH, *Water Commissioners, Hadley Water Supply District.*

GENTLEMEN: — The State Board of Health has considered your application received Feb. 12, 1906, requesting the approval by this Board of the taking of certain additional sources of water supply under the provisions of chapter 146 of the Acts of the year 1905, the sources mentioned being: (1) the stream on which the present reservoir is situated, but at a point about a quarter of a mile below the reservoir; and (2) Shingle Mill Brook, at a point about three-quarters of a mile above its junction with Harts Brook, and at approximately the same level at which it is proposed to take the water from the stream on which the present reservoir is situated. The points of taking are indicated upon a plan accompanying your petition, and are described in a communication from your engineer submitted therewith.

The Board has caused the present and proposed new sources of water supply to be examined by one of its engineers and has considered the plans presented.

It appears that, on account of the loss of water by leakage from the reservoir from which the present supply is drawn, there is a doubt as to whether the present source will yield enough water for present requirements, especially in view of the possible enlargement of the district; but it does not appear that the limits of the district are to be extended during the year, nor does the evidence as to the yield of the present source show that it will be insufficient for the supply of the district at all times.

The proposed new sources of supply are at a considerably lower level than the present reservoir, and, if they should be used, the pressure in the water pipes of the district would be considerably diminished. It is not unlikely, moreover, that if there is a serious leakage from the present reservoir it can be prevented at much less expense than would be required to extend the works by taking other sources of supply.

Considering the circumstances, the Board does not at the present time approve the proposed takings, but would advise that further observations be made as to the quantity of water used by the district and the yield of the present source; and that, if it is found that a large quantity of water is now being lost by leakage, a careful investigation be made, to determine the practicability of preventing the excessive waste of water in this way. When the results of these investigations are available, the Board will advise you as to the most appropriate method of enlarging your water supply if a larger supply shall be found necessary.

### Haverhill (Island Park Box Factory).

April 5, 1906.

*To the Board of Health of the City of Haverhill.*

Gentlemen: — In response to your communication requesting an examination of the water of a well used to supply drinking water in the Island Park Box Factory and dwelling houses in its neighborhood, the State Board of Health has caused the well and its surroundings to be examined by one of its engineers and several samples of its water to be analyzed during the past winter.

The results of the analyses show that the water has at some time been considerably polluted, and that it contains more organic matter than is found in good well waters. The well is uncovered and exposed to pollution by surface water, and under existing conditions is not a safe source of drinking water. The Board is of the opinion, however, that, if the curbing of the well should be carried above the ground and made tight for a considerable distance below the surface, so as to exclude surface water, and the well should be covered to prevent polluting matters from falling or being thrown into it, the water might safely be used for drinking.

### Holyoke.

Feb. 1, 1906.

*To the Board of Water Commissioners of the City of Holyoke,* Mr. A. E. Pickup, *Registrar.*

Gentlemen: — The State Board of Health has considered your application requesting an examination of several groups of buildings on the water-shed of Ashley Lake, your principal source of water supply, and information as to whether they are dangerous from a sanitary standpoint, and has caused the locality to be examined by one of its engineers.

From this examination it appears that the land around Ashley Lake is largely controlled by the city of Holyoke, and contains no serious sources of pollution; but near the northerly end of the water-shed of one of its tributaries, known as Tannery Brook, there are several groups of farm buildings, and in the water-shed of Bray Brook there are a farmhouse and group of outbuildings and a club house and picnic grounds, drainage from which must find its way directly or indirectly into the streams.

There was no evidence at the time this examination was made that the streams were being polluted from the farm buildings; but the club house and picnic grounds are located on a steep hillside, and there appears to be much danger that polluting matter deposited upon or in the ground at this place may enter the brook. The purity of the water of this water-shed can be protected by the enforcement of suitable sanitary rules and

regulations; and the Board would recommend that you secure the adoption of such regulations, and make provision for their thorough enforcement. The Board will make the necessary rules, if you so request.

### HOLYOKE (WELL AT SCHOOLHOUSE).

DEC. 6, 1906.

*To the Board of Public Works of the City of Holyoke.*

GENTLEMEN: — In response to your request for an examination of a well used as a source of water supply for the West Holyoke school building, and advice as to its quality, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water of this well is at the present time unpolluted and safe for drinking. Should additional buildings be constructed in the region about the well, the water should be examined from time to time, so that any deterioration may be noted and the use of the well be discontinued if the quality of the water should deteriorate.

### LAWRENCE (WOOD WORSTED MILLS).

JUNE 7, 1906.

To Mr. B. F. SMITH, Jr., *Treasurer, Wood Worsted Mills, Boston, Mass.*

DEAR SIR: — In response to your request received May 18, 1906, for advice as to the quality of the water of a certain well which it is proposed to use as a source of water supply for the Wood Worsted Mills in Lawrence, the Board has caused the well to be examined by one of its engineers, who reports that it is not yet completed, and that it is impracticable to obtain a sample of its water.

A sample sent in by you recently from this source contained foreign matter, which evidently affected its quality unfavorably.

When the well has been completed, and enough water pumped from it to clear the water of foreign matter, the Board will cause it to be examined, if you so request.

### LINCOLN.

APRIL 5, 1906.

*To the Committee on Claims of the Town of Lincoln.*

GENTLEMEN: — The State Board of Health received from you on Jan. 29, 1906, the following communication for advice with regard to the sufficiency of the water supply of Sandy Pond for the requirements of the towns of Lincoln and Concord: —

The towns of Lincoln and Concord both take their water supply from Sandy Pond, which is situated in Lincoln. The statute under which this is done (Acts of 1872, chapter 188, section 11) provides that, if the water of

said pond shall prove insufficient for both, the town of Lincoln shall be first supplied.

The water commissioners of the town of Lincoln are of the opinion that the condition of Sandy Pond is such that the supply of that town will be endangered if Concord continues to draw therefrom; and they have requested the committee on claims of the town to take necessary steps to secure the sufficiency of the town's supply.

The committee on claims, therefore, request that your board will advise them with regard to the sufficiency of this water supply, especially with reference to the existing and future needs of the town of Lincoln and of the town of Concord.

It appears that observations have been made from time to time of the height of water in Sandy Pond, and that a record has been kept in recent years of the quantity of water pumped for the supply of the town of Lincoln, but that no records have been kept of the quantity used by the town of Concord. The results of surveys are available which show the area of the pond and its capacity above the level of the bottom of the intake pipe of the town of Concord, which is apparently about 7 feet below the present level of full pond.

Taking the area and capacity of the pond and the area of the watershed, as shown by these surveys, and calculating the quantity of water used from the pond in various periods, it appears that the quantity of water now being drawn from the pond is approximately equal to its yield under present conditions in a series of very dry years; and that, in order to obtain this quantity in a very dry period, it will be unnecessary to draw the pond down to a level more than about 7 feet below the present level of full pond.

Below this level, however, there is still a large quantity of water stored which could be made available for the use of the towns at comparatively small expense, by extending the intake pipe of the town of Lincoln into deeper water, and by providing a temporary pump to pump into the supply mains of the town of Concord, as has been done in other places under similar circumstances. The Board is unable to find any evidence that a limit has been established or agreed upon below which the water may not be drawn down; and if this is the fact, the towns might still go on using water from the pond at approximately the present rate for several years, even if there should occur a series of years as dry as any of which we have record, before the supply would become exhausted.

The quantity of water drawn from Sandy Pond by each of the towns appears to be excessive, and the Board would advise that an examination be made to determine how much water, if any, is lost by leakage from the pipe systems, in order that such losses may be prevented. It is not

essential, in the opinion of the Board, that the use of water from the pond be immediately restricted; but the Board would advise that means be provided as soon as practicable for measuring with reasonable accuracy all of the water drawn or discharged from Sandy Pond, and that observations be made of the height of water, so that its yield and capacity can be determined and the use of water from the pond restricted to the amount that it is capable of supplying continuously.

The rules and regulations adopted by the Board on Sept. 3, 1903, for the sanitary protection of the water supply of the town of Lincoln, were amended by the Board on Dec. 6, 1906, so as to provide for the regulation of boating, fishing, ice cutting, etc., thereafter by the State Board of Health, instead of the local water board.

## LYNN.

FEB. 1, 1906.

To Mr. WILLIAM B. LITTLEFIELD, *President, Lynn Public Water Board, Lynn, Mass.*

DEAR SIR: — The State Board of Health received from you on Jan. 1, 1906, the following communication relative to certain proposed changes in the Lynn water supply: —

The Lynn Public Water Board hereby makes application to the State Board of Health for its approval to lay pipe or conduit from Montrose (where we tap Saugus River for a portion of our supply) to Beaver Dam Brook, also connect with Pillings Pond and discontinue the use of Saugus River as a supply. It is our purpose in the future to extend the proposed line of pipe to the Ipswich River for an additional supply, which right was granted to Lynn by the Legislature in the year 1901.

The Board, in a communication to your board, Nov. 5, 1903, with reference to the protection of the purity of your sources of water supply, has already advised you to make changes such as the first proposed in the above application, the portion of that communication relating to this matter being as follows: —

There are portions of the water-shed above Montrose which are comparatively sparsely populated, and from which it appears to be practicable to secure water which would be safe for drinking, if rules for the sanitary protection of the water should be enforced. These areas include the water-sheds of Beaver Brook and Pillings Pond; and, judging from the State map, it may be practicable to extend a conduit from the neighborhood of your present intake on the Saugus River along the northwesterly side of that stream, so as to intercept the waters of these sources; and, if it is necessary to use water from the Saugus River water-shed above Montrose, the

**water of these portions only should be used, and the polluted waters flowing in the main stream at your present intake should be excluded. It is also possible to purify the water of the river by filtration through sand.**

**In the opinion of the Board, the use of the Saugus River as a source of water supply, as at present, constitutes a great danger to the health of the inhabitants of the city of Lynn, and the use of this source in its present condition should be discontinued immediately.**

No plans of the pipe line or conduit now proposed have been presented, and the Board will be unable to give you further advice as to the proposed changes until further information is presented.

Regarding the proposed plan of taking water from the Ipswich River, the Board will give you such advice as it can in the matter, if you will submit your plans.

### LYNN (SPRING NEAR STERLING STREET).

JULY 5, 1906.

*To the Board of Health of the City of Lynn*, MR. GUSTAVUS A. BADGER, *Clerk*.

GENTLEMEN: — In response to your request, received June 20, 1906, for an examination of a spring near Sterling Street in Lynn, from which water is sold to the public for drinking, the State Board of Health has caused the spring and its surroundings to be examined and has analyzed a sample of the water collected by you and sent to this office June 26.

The results of the analysis show that the water contains a larger quantity of organic matter than is found in good spring waters, and there are evidences that part at least of the water entering the spring has been polluted, though subsequently well purified in its passage through the ground before entering the spring. Under the circumstances, there is doubt as to the safety of this water for drinking. The excess of organic matter may be due to the exposure of the water to light in the basin from which the sample was taken; but it is probable that, if the spring were walled up and covered so as to prevent effectively the entrance of surface water and to exclude light, the water of this source might safely be used for drinking.

If these changes shall be made, the Board will make a further examination, if you so request.

### LYNN (SPRINGS).

OCT. 4, 1906.

*To the Board of Health of the City of Lynn.*

GENTLEMEN: — In response to your request for an examination of various springs in Lynn from which water is distributed for drinking, and advice as to the quality of their waters, the Board has caused five springs indicated by you, viz., the Moose Hill, Electric, Sterling Street,

Graham and Pocahontas springs, so called, to be examined and samples of their waters to be analyzed.

The Moose Hill Spring is situated in a densely populated neighborhood, and its waters are highly polluted. The Board would advise that measures be taken to prevent the further use of this water for drinking.

The Graham Spring also shows evidence of very serious pollution, caused doubtless by the group of buildings on the slope above it. The Board would advise that the further use of water from this spring for drinking should be discontinued.

The quality of the water of the Electric Spring has not apparently changed from its condition when examined in 1900, and in its present state the water of this spring is probably safe for drinking. The Board would advise, however, that the water be examined from time to time, in order that the use of the spring may be discontinued if the quality of the water should deteriorate.

The water of the Sterling Street Spring is, on the whole, of somewhat better quality than when examined last June, and is probably in its present state safe for drinking. This water should also be examined from time to time, in order that the use of the spring may be discontinued if the quality of the water should deteriorate.

The conditions affecting the Pocahontas Spring, so called, located near Lowell Street in Lynnfield, do not appear to have changed since the examination made by the Board in 1902, when the following advice was given as to the quality of the water: —

The results of the analysis show that the water is of good quality for drinking, and an examination of the surroundings shows that there are no buildings on the water-shed of the spring which would be liable to affect the quality of its water.

In the opinion of the Board, this spring, under present conditions, is a safe source of drinking water supply.

## MANCHESTER.

FEB. 1, 1906.

*To the Board of Water Commissioners of the Town of Manchester,* Messrs. NATHAN P. MELDRUM, JAFFREY T. STANLEY and FREDERICK J. MERRILL.

GENTLEMEN: — The State Board of Health received from you on Jan. 2, 1906, an application for advice with reference to a proposed additional water supply for the town of Manchester, to be taken from wells in the Beaver Dam meadow near Sawmill Brook, about one mile above your present pumping station, containing a statement of the need of an additional supply, the sources investigated, and an outline of a proposed plan of obtaining an additional supply for the town from the source

indicated. The results of experiments upon the purification of the water, which, though taken from an uninhabited region and unaffected by sewage pollution, contains an excessive quantity of iron, which would make it very objectionable for many uses, are also described; but you state that these experiments have not been carried far enough to determine whether or not sand filtration will remove the excess of iron.

The plan now proposed is shown on the drawings submitted with the application, and is described therein as follows: —

The proposed plant will consist of about twenty-five driven wells, 2½ inches in diameter, connected to a suction main (probably 16 inches in diameter, to provide for future extensions of the system), which will be laid about 10 feet below the surface of the meadows, and into which the wells will discharge by gravity, for the present at least.

The 16-inch suction pipe will be laid with a slightly rising grade to the Beaver Dam, where an air-chamber will be placed and connected with a main from Beaver Dam to the present pumping station. This main will be laid on a falling grade to the pumping station, and will have a total fall from the bottom of the suction main of the well system to the surface of the ground of the present dug well of about 19 feet.

It is proposed to make this main, which will be 4,600 feet long, 14 inches in diameter. . . .

There is a possible supply of ground water in the Beaver Dam meadow, which, judging by the results obtained in preliminary test wells and by the area and character of the water-shed and meadows, is capable of furnishing an abundant supply for the prospective needs of Manchester. The water, however, as shown by analyses of samples pumped from the wells, has an excess of iron, which precludes its use unless the iron is removed by filtration or some other treatment. . . .

If the Beaver Dam meadow is the only available source for an additional supply, it is evident that it must finally be adopted, and the iron removed in some way. This has been done in other places, and, while some method more expensive than plain sand filtration may be necessary, it is certain that it can be done, and, under the conditions prevailing here, must be done.

It is, therefore, proposed that an appropriation be made sufficient to put in a plant of limited extent, comprising a sufficient number of wells for present needs in the case of a dry year, and a pipe line to the present pumping station; that the plant be installed as early in the season as possible; also, that the filtration experiments be renewed and carried on (in connection with other types of experimental treatment, if such seem desirable) until it is determined what kind of treatment is necessary to remove the iron from the water. In the mean time, if there is a shortage of water in the present supply, the new plant can be used to supplement it.

In the first year in which it will be necessary to use the new plant but a small proportion of the entire consumption of water will be supplied from it;

and the dilution with the present supply will be so great that the iron in the water from the new supply, even if the latter is used without filtration, will not cause trouble.

The new plant will be so arranged that the water can be thoroughly mixed with that of the present supply, and the quantity admitted perfectly controlled to meet the absolute needs.

It is estimated that the cost of the plant required at present will be from $30,000 to $35,000, dependent largely upon the location of the initial lot of wells.

If further experiments upon the treatment of the water to remove the iron are postponed until the new plant is installed, an excellent opportunity will be afforded for such treatment, as the water would then be more nearly what may be expected than that taken from a single well, as now; and it would be delivered at or near the present pumping station by gravity, with sufficient head to permit of its most convenient use.

In this plan submitted for your advice it is, therefore, proposed to install the plant substantially as described above, and to make further experiments to determine the best treatment of the water to remove the iron, the experiments to be begun either as soon as the weather is suitable in the spring, or upon the installation of the plant. The latter plan will be much less expensive, and will treat the same water which it is proposed to use; while, if the present experiments are renewed, the water will be that from one location only.

It is proposed, if authority is given, to install the well plant very early in the season, which will give an opportunity to make the experiments on the treatment of the water during the season of 1906. There will be nothing to prevent their being continued into the winter, if necessary, as they can be made in a warm place at or near the present pumping station, with a minimum of expense for attendance.

The Board has caused the proposed source of supply to be examined by its engineer, has considered the probable requirements of the town of Manchester as to water supply, and has examined the plan submitted and the results of the experiments upon the purification of the water.

While there has not been a material increase in the use of water since the last addition to the sources of supply was made by driving wells near the pumping station about four years ago, the yield of the present sources is evidently insufficient for the requirements of the town in a dry season, and an additional supply is necessary.

Several localities in and about Manchester have been investigated, and tests made to determine the practicability of obtaining therefrom a suitable additional water supply for the town; but none has been found which appears to be capable of furnishing an adequate quantity of good water. The conditions for obtaining a large additional supply from the

source now selected — the ground in the Beaver Dam meadow about a mile above the present pumping station — are favorable, in that the tubular test wells driven in this region penetrated a stratum of coarse sand and gravel of considerable depth, from which water can be drawn freely when pumping with a hand pump; but the water is affected by the presence of an excessive quantity of iron, which would make it very objectionable for many domestic uses. The region in which the wells are located is uninhabited, and the water is unaffected by sewage pollution, and, if freed from the excess of iron, would doubtless be satisfactory for all domestic purposes.

The experiments upon the purification of this water were begun in October last and continued until the end of December. Four filters were used in these experiments, as described in your application, and water was obtained from one of the tubular test wells previously driven, known as well No. 1.

The quantity of iron in the effluent of the various filters varied somewhat at different times, but, on the whole, increased quite constantly up to the end of the test.

The quantity of iron present in the water of the various wells in Beaver Dam meadow, which were driven several years ago and most of which have been flowing for four years, has been found to vary considerably from time to time; and, upon comparing the average quantity of iron present in the waters of the different wells at various times, it is found that the water of well No. 1, used as the source of supply in these experiments, has contained less iron than is found in the water of four of the other wells in this region, and about the same quantity as that usually found in the water of a fifth well. It is probable, judging from these results, that the quantity of iron present in the ground water in this meadow is greater, on the average, than in the water of the well used in these experiments.

The results of examinations of ground waters containing an excessive quantity of iron have shown that the quantity of iron tends to increase with the continued use of the source, and the quantity of organic matter in the water also increases. Moreover, waters containing an excessive quantity of iron have been found to vary greatly in character at different seasons of the year, and methods that have been found adequate for the purification of the water at one time have been found to be unsuccessful at another. Some waters containing an excessive quantity of iron have been found very difficult to purify by any method.

Considering the unsatisfactory character of the results of the tests thus far made, it is essential, in the opinion of the Board, that further and more thorough tests be made before the practicability of purifying

this water can be ascertained or the methods necessary for its successful purification can be determined with certainty.

There is, furthermore, always an uncertainty as to the probable yield of a ground-water source such as this, and a more thorough test is necessary before its approximate yield can be determined.

In view of the probable cost of the works necessary for collecting the water and conveying it to the present pumping station, as stated in the application, the uncertainty as to the yield of the source and especially as to the practicability of purifying the water satisfactorily, and the lack of information as to the character and cost of works which may be necessary therefor, the Board does not advise that the works be constructed for conveying this water to the pumping station at the present time, but would alvise that further tests be made, to determine the probable yield of the source and the means necessary for the purification of the water.

These further investigations should be made under the direction of your engineer, and the Board will assist you by making all the necessary analyses of samples of water, and will give you further advice when the results of further investigations are available.

## Marblehead.

Aug. 2, 1906.

*To the Board of Water Commissioners of the Town of Marblehead.*

Gentlemen: — In accordance with the request of a member of your board for information as to the cause of the objectionable condition of the water supplied to Marblehead, and advice as to a remedy therefor, the Board has caused the sources of supply and their surroundings to be examined by its engineer and has considered the results of the analyses of water from these sources made during the present and previous years.

These results show that this water contains at all times such an excessive quantity of iron as to make the water unfit for many domestic uses. The analyses also show that there has been very recently a marked increase in the quantity of chlorine present in the water.

Experiments upon the purification of this water made eight years ago showed that, as its condition was at that time, it could be thoroughly purified and made satisfactory for all domestic uses by aeration and subsequent filtration through sand. There were indications at that time, however, that the supply of water was limited; and since that time the quantity of water used has greatly increased, and it has become evident that the capacity of the works is insufficient for the requirements of the town in a dry season.

Under these conditions, the question of the best method of increasing

the water supply has become of the greatest importance, and, in the opinion of the Board, should be given immediate consideration.

It is very doubtful, in the opinion of the Board, whether a sufficient additional supply of water of suitable quality for water-supply purposes can be obtained within the limits of the town of Marblehead or at any other place in the neighborhood of the present works; and it may be found desirable to abandon the present sources and obtain a supply of water for the town in some other way.

Under the circumstances, the Board would advise that you take up without delay the question of securing an additional water supply, and that, in making your investigations, you secure the assistance of an engineer of experience in such matters. If it should be found practicable to secure an additional supply of water sufficient, if used in connection with present sources, to meet the requirements of the town for a considerable time in the future, the question of purifying the present supply can then be considered.

The Board will give you such assistance as it can in making the necessary investigations with reference to enlarging and improving the water supply, and will give you further advice in this matter when you have the results of further investigations to present.

### Marion (Well near Town Hall).

Oct. 4, 1906.

To Mr. William A. Andrew, *Secretary, Board of Health, Marion, Mass.*

Dear Sir: — In response to your request for an examination of the water of a well near the town hall, used as a source of water supply by school children, and advice as to its quality, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water is turbid and colored, has an offensive odor, and contains a much greater quantity of organic matter than is found in good well waters. There appear to be no sources of sewage pollution in the immediate neighborhood of the well, however, and it is possible that the condition of the water is due to decaying organic matters deposited in the well; and the quality of the water might improve if the well should be cleaned out and a considerable quantity of water pumped subsequently therefrom. In its present state, the water of this well is not suitable for drinking; but if the well shall be cleaned out, the Board will make a further examination of the water, if you so request.

### MATTAPOISETT.

MAY 3, 1906.

To Hon. CHARLES S. HAMLIN, *Village Improvement Association, Mattapoisett, Mass.*

DEAR SIR: — The State Board of Health has considered your request for advice as to a water supply for Mattapoisett, to be furnished by the Fairhaven Water Company from the auxiliary works of that company in the valley of the Mattapoisett River, and has caused the proposed source of supply to be examined by its engineer.

According to the information available to the Board, the sources from which water is drawn at these works consist of twenty 2½-inch tubular wells, driven to depths of 25 to 30 feet, located on the southwesterly side of the river, a short distance above the highway leading from Mattapoisett to Fairhaven. The wells are used only as an auxiliary supply, generally in the late summer or early fall; and definite information is lacking as to the quality of the water or the quantity obtainable continuously from this source, though it appears that a large quantity of water has been drawn from the wells for short periods.

The conditions appear to be favorable for obtaining a supply of good water for the village of Mattapoisett from these wells; but the Board would recommend that, before deciding upon the plan of taking water from this source, a test be made by pumping from the wells for a period of at least a week at a rate of as much as 200,000 gallons per day, in order to obtain more definite information as to the probable quantity and quality of water obtainable from this source.

The Board will assist in these investigations by making the necessary analyses of the water, and will give you further advice when the results of a test are available.

### MAYNARD.

DEC. 6, 1906.

*To the Board of Water Commissioners of the Town of Maynard.*

GENTLEMEN: — The State Board of Health received from you on Nov. 1, 1906, an application requesting an examination of Taylor Brook, and advice as to whether this stream would be an appropriate source of water supply for the town of Maynard; and in response to this application the Board has caused the proposed source of supply to be examined by its engineer and a sample of the water to be analyzed.

The results of the analysis show that the water of Taylor Brook had at this time a very high color, and contained an excessive quantity of organic matter. A considerable portion of the water entering this stream is derived from Puffer's Pond, and the analysis of the water of that source shows that it also is highly colored and similar in quality to the water of the brook. While the water-shed of Taylor Brook contains

comparatively little population, the water of this source is naturally of such poor quality that it would be very objectionable for water-supply purposes.

It appears that in 1902 the question of an additional water supply for Maynard was carefully considered by you, and that a report as to enlarging and improving the supply was made at that time by Mr. Freeman C. Coffin, and is published in your annual report for that year. As a result of Mr. Coffin's investigations, it appears that your present supply is derived in part from White Pond and in part from ground water filtering into the 12-inch conduit leading from White Pond to your pumping station near the Assabet River. It was found during these investigations that, while a large quantity of water enters the conduit, chiefly near its upper end, a considerable quantity leaks out of it near the lower end, where the conduit is laid above the level of the ground water; and that it would be practicable, by providing a tight conduit from the pumping station up to the third chimney on the present main above the pumping station, to increase materially the amount of water available at the pumping station for supplying the town. Mr. Coffin recommended that this improvement be made, and that ultimately a new cast-iron main be laid through the entire distance from White Pond to the pumping station, and that a pumping plant be erected at the pond to pump water into the main whenever the water level should fall so low that a sufficient supply would not flow to the pumping station by gravity.

Under the conditions which now exist, the capacity of the conduit for conveying water from White Pond to the pumping station is inadequate to deliver enough water for all of the requirements of the town at all times, and the Board is informed that in times of emergency in the past water has been drawn directly from the Assabet River. This stream is highly polluted, and the introduction of its water into the water-supply system is likely to cause great injury to the health of the town. It is probable, in the opinion of the Board, that White Pond is capable of yielding enough water for the present requirements of the town, and to allow for a considerable increase in the use of water in the future if provision should be made for utilizing all of its available yield. It is desirable, however, to retain also the supply of ground water that filters into the present main, and to increase the supply from the ground in this region if possible.

The Board would recommend that the town take action without unnecessary delay to provide an adequate supply of good water to meet its requirements at all times.

### MEDWAY (WELL AT SCHOOLHOUSE).

APRIL 5, 1906.

*To the Board of Health of the Town of Medway.*

GENTLEMEN: — In response to your request of March 31, 1906, for an examination of a well located in the school yard near the corner of North and School streets, and used as a source of drinking water supply by the children at this school, the State Board of Health has caused the well and its surroundings to be examined and a sample of its water to be analyzed.

There are many cesspools and other possible sources of pollution not far from the well, and the results of the analyses show that the water has been very highly polluted, and, though subsequently partially purified in its passage through the ground before entering the well, still contains a larger quantity of organic matter than is found in good well water.

In the opinion of the Board, the well cannot be regarded as a safe source of drinking water supply; and the Board would recommend that its use be discontinued and a supply of water obtained from some suitable source.

### MEDWAY (SPRING IN WEST MEDWAY).

JULY 5, 1906.

To NORMAN P. QUINT, M.D., *Medway, Mass.*

DEAR SIR: — In response to your request for an examination of the water of a spring used as a source of water supply by several families in West Medway, the Board has caused the locality to be examined by one of its engineers and samples of the water to be analyzed.

The results of the analyses show the presence of a larger quantity of organic matter than is found in good ground water, and there are indications that some of the water entering the spring has been polluted and not subsequently well purified in its passage through the ground. It is probable that the pollution is due in part to the fertilizers used upon the cultivated lands on the bluff above the spring and in part also to the entrance of surface water; and if the pollution from the cultivated land shall be prevented and the spring covered and protected from the entrance of surface water, water of better quality can probably be obtained from this source. Should these changes be made, the Board will, if you so request, make a further examination of the spring, to determine whether its waters may safely be used for drinking.

## MEDWAY (WELLS AT SCHOOLHOUSES).

NOV. 1, 1906.

*To the Board of Health of the Town of Medway.*

GENTLEMEN: — In response to your request for an examination of certain wells used as sources of water supply at three schools in Medway, the Board has caused the wells to be examined and samples of their waters to be analyzed.

The water supply of the school located near the corner of Milford and Fisher streets, about one and one-half miles west of the center of West Medway, is obtained from a well about 15 feet deep, located in the school yard. The water of this well does not appear to be polluted by sewage, but the well is covered with loose boards, and is not provided with a trough for conducting away the waste water, so that much of the water pumped finds its way back into the well through the cracks in the cover, carrying such polluting matter as may be deposited there. If a tight cover were provided for this well, and provision made for conducting away the waste water, the well, in the opinion of the Board, would be a safe source of water supply for the school.

The well at the school on High Street shows evidence of considerable pollution, and its top is at about the same level as the street close by. Under present conditions, surface water may enter it at times of rain, and this well, in its present condition, is not a safe source of water supply. It is probable that if the curbing of the well should be carried a sufficient distance above the surface of the ground and made tight, so as to prevent the entrance of surface water, and a proper cover and means for carrying off the waste water provided, the water of this well would be safe for drinking. After the changes are made, the Board will make further analyses, if you so request.

The school in Medway village it appears is now supplied from a well located on Lincoln Street, just over the boundary line in the town of Franklin. There are several sources of pollution in the immediate neighborhood of this well, and analysis shows that it has been polluted, and that the water contains a greater amount of organic matter than is found in good well waters. In the opinion of the Board, this well is not a safe source from which to take water for drinking.

## MONTAGUE (MILLERS FALLS WATER SUPPLY DISTRICT).

JAN. 4, 1906.

To Messrs. FRANK H. GILES, J. E. KAVENAUGH and M. W. CARROLL, *Board of Water Commissioners of the Millers Falls Water Supply District.*

GENTLEMEN: — The State Board of Health received from you on Dec. 16, 1905, an application for advice with reference to taking a water supply for the Millers Falls Water Supply District from Green Pond in

the town of Montague, in which you outline your proposed plan as follows: —

It is proposed to take a supply from Green Pond in the town of Montague for the use of the whole or any part of the district, and to pump the same into and through the mains now laid in the district and into a distributing reservoir to be constructed on the high land on the north side of the Millers River in the town of Erving, said land being within the corporate limits of the district.

The advice of your Board as to the suitability of Green Pond for the uses above described is respectfully requested.

In response to this application, the Board has caused Green Pond and its surroundings to be examined by one of its engineers and a sample of its water to be analyzed. The results of the analysis and of previous analyses of this water show that it is of good quality for the purposes of a public water supply, and the water-shed of the pond appears to be free from possible sources of pollution. The quantity of water which the pond is capable of supplying cannot be determined definitely, but, so far as the Board is able to judge from the information available, the quantity is ample for all the requirements of the district.

In the opinion of the Board, Green Pond is an appropriate source of water supply for the Millers Falls Water Supply District.

The soil in the region about Green Pond appears to be coarse and porous, and the conditions appear to be favorable for obtaining water from the ground by means of wells. The water of Green Pond will probably be of good quality usually, but it may be affected at times, like the waters of similar sources, by growths of organisms which impart to the water a disagreeable taste and odor; while water obtained from the ground, on the other hand, where the conditions are favorable, is at all times clear and odorless, and has a lower temperature in summer than the water of a surface source. The Board would advise that, before building works for taking water directly from Green Pond, you consider the practicability of obtaining a supply from the ground by means of wells or other suitable works.

The Board will assist you in making investigations as to a ground-water supply by making the necessary analyses of water, and will give you further advice when you have the results of investigations to present.

## NEEDHAM.

Nov. 1, 1906.

*To the Board of Water Commissioners of the Town of Needham.*

GENTLEMEN: — In response to your request for information as to the quality of the water now supplied to the town of Needham, the State Board of Health has caused the wells from which the supply is drawn

and their surroundings to be examined by its engineer, and has considered the results of the analyses of their waters.

It appears, from the information furnished the Board, that at the present time and during the summer just passed water has been supplied from wells Nos. 1 and 2, and that no water has been drawn from any other source. It does not appear that any material change has taken place in the surroundings of these wells, and there are no sources of pollution in their immediate neighborhood. The character of the water has not changed materially in the case of either well from the earlier years of its use, and the water continues to be of good quality for all the purposes of a public water supply.

### NEWBURY (DUMMER ACADEMY).

FEB. 1, 1906.

To Mr. WALTER L. COLBY, *Secretary, Dummer Academy, 42 Colberg Avenue, Roslindale, Mass.*

DEAR SIR: — In response to your application of Jan. 4, 1906, for an examination of the well used as a source of water supply at the Dummer Academy in South Byfield, the Board has caused the well and its surroundings to be examined and samples of its water to be analyzed.

The results of the analyses show that the water contains a somewhat larger number of bacteria and a slightly greater quantity of organic matter than are found in good ground waters. It appears that there is an overflow from the well to a brook near by, through which brook water is said to back up at times of heavy rain and enter the well. While there are sources of pollution at no great distance, it is probable that the water would be safe for drinking if the entrance of surface water were prevented.

In the opinion of the Board, this well cannot, under the present conditions, be regarded as a safe source of drinking water.

### NORTH ADAMS (CITY FARM).

OCT. 4, 1906.

*To the Board of Health of the City of North Adams.*

GENTLEMEN: — In response to your request for an examination of the condition of the water supply used by the city farm, and advice as to its quality, the Board has caused the source of supply to be examined and a sample of the water to be analyzed.

The results of the examination show that the water supplied to the city farm is at present taken from a reservoir on a small stream flowing from Hoosac Mountain. The water-shed of this stream is uninhabited, and the water is naturally of good quality for water-supply purposes; but the reservoir in which it is stored contains much mud and organic matter, which evidently has a very unfavorable effect upon the quality of

the water. If the reservoir should be cleaned by the removal of all of the soil and organic matter from its bottom, it is probable that water of good quality could be obtained therefrom which would rarely have a noticeable taste or odor; and the Board would advise that this reservoir be cleaned if the use of this source is to be continued.

### NORTHAMPTON (HOLYOKE CANOE CLUB).

JUNE 7, 1906.

To FRANK A. WOODS, M.D., *Holyoke, Mass.*

DEAR SIR: — In response to your request for advice as to the quality of the water of a certain well, which it is proposed to use as a source of water supply at the Holyoke Canoe Club, the Board has caused the well and its surroundings to be examined and samples of its waters to be analyzed.

The results of the analyses indicate that the water entering the well is quite hard, and has at some time been polluted and not thoroughly purified in its subsequent passage through the ground before entering the well, and the Board cannot advise its use for drinking. It is probable that the quality of the water of this well is unfavorably affected by certain dwelling houses and outbuildings in its neighborhood, and especially by the fertilizers used upon the cultivated land in its immediate vicinity.

### NORTHAMPTON (WELLS AT LAUREL PARK).

NOV. 1, 1906.

To DR. E. W. HIGBEE, *Northampton, Mass.*

DEAR SIR: — In accordance with your request for an examination of the water of certain wells at Laurel Park in Northampton, and advice as to its quality, the Board has caused four wells, or springs, known respectively as the Auditorium, the High Rock, the Hildreth and the Trinity springs, to be examined by one of its engineers and samples of their waters to be analyzed.

None of the wells shows very serious evidences of sewage pollution, but all of them are so situated that they are liable to be polluted by matters thrown upon the ground from the numerous cottages in their neighborhood or by visitors to the park, of whom there are sometimes very large numbers in the summer season.

It is not advisable, in the opinion of the Board, to use these springs as sources of water supply without more adequate protection than is afforded under present conditions. The Board would recommend that, if practicable, a general water supply for the park be secured from some source of known purity, and that the further use of these wells or springs be abandoned. The Board will, upon request, advise you as to any source of water supply for the park that you may select.

## NORTON.

FEB. 1, 1906.

To A. M. ROUND, M.D., *Agent of Board of Health, Norton, Mass.*

DEAR SIR: — The State Board of Health received from you on Jan. 4, 1906, an application stating that you have been requested by the Citizens' League of the town of Norton to consult this Board with regard to a water supply for that town, and containing the following statement as to the sources of supply under consideration: —

The advisability of taking water from the systems of either Attleborough or Mansfield or of establishing one in the town is to be considered. A desire to have the State Board pass upon the best source of supply before taking much of any action in the matter has been expressed by the preliminary committee. A collection of springs, making a pool some 100 feet across, that has never been known to freeze over, has been mentioned as a possible supply. They are located in the northeast section of the town, and are the source of the Tucker Brook that flows into the Canoe River. This river has its source in springs in Sharon, and a little below where the Tucker Brook empties into the river has been mentioned as a better location for taking the water and establishing a pumping station and standpipe. Some filtering scheme would be a part of the latter plan, probably. Two or three possible sources being under consideration, you will please govern yourselves accordingly.

In addition to the sources indicated, you have subsequently called the attention of the engineer of the Board to three other possible sources: (1) the Wading River; (2) a spring near the factory of A. R. Sweet; and (3) certain springs in the neighborhood of the Rumford River, about a mile and a half southeast of the village of Norton.

In response to this application, the Board has caused the various sources to be examined by its engineer and has caused samples of water from certain of the sources to be analyzed.

The sources of water supply of both the town of Attleborough and the town of Mansfield furnish water of excellent quality for domestic purposes, and either source is probably capable of furnishing a sufficient quantity of water for the requirements of the town of Norton, in addition to its other requirements.

Of the other sources proposed, neither the Canoe River nor the Wading River would be a suitable source of public water supply for the town of Norton unless the water should be efficiently filtered; and even in that case these streams would not furnish water of as good quality as can probably be obtained from either of two possible ground-water sources to which you have called attention.

The spring near the factory of Mr. A. R. Sweet is located so near the

town that the quality of the water would be likely to be objectionable; and, judging from surface indications, it would not be practicable to obtain an adequate water supply for the town in this region.

The spring near the head of Tucker Brook in the extreme northern part of the town would furnish water of excellent quality for all the purposes of a public water supply, and it is likely that enough water could be obtained from this source and the ground in its neighborhood for the supply of the town of Norton; but further investigation should be made, to determine the probable capacity of this source, before plans are prepared for supplying the town therefrom.

The results of an analysis of a sample of water from a spring near the Rumford River, about a mile and a half southeast of the village, show that the quality of this water is excellent for the purposes of a public water supply; and the conditions, so far as can be judged from surface indications, appear to be favorable for obtaining a sufficient supply of water from the ground in this region.

The cost of works for supplying the town of Norton with water from the ground in this locality would probably be considerably less than the cost of a supply from the neighborhood of Tucker Brook.

The Board would advise that you make further investigations of the practicability of obtaining a ground-water supply in this region by sinking test wells at some place where the conditions are most favorable, and by connecting together a number of wells and pumping from them for a period of a week or more, at a rate such as would be necessary for the supply of the town; and that you cause samples of the water to be analyzed from time to time during the test, to determine the quality of the water.

The Board would also advise that these investigations be made with the assistance of an engineer of experience in the selection of ground-water supplies. The Board will assist you in further investigations by making the necessary analyses of the water, and will give you further advice when the results of further tests are available.

JUNE 7, 1906.

To Messrs. F. W. HOLDEN and GEORGE E. SMITH, *Committee on Water Supply of the Norton Fire District.*

GENTLEMEN: — The State Board of Health received from you on May 22, 1906, an application for advice relative to a proposed water supply for the village of Norton, in which you mention four possible sources of supply, as follows: —

1. The Talbot Spring, being about 100 rods west of the Norton Mills.
2. The Cook Spring, a spring on the farm of Davis Cook, and about 1,000 feet from Taunton Avenue.

3. The Smith Spring, a spring on the Charles H. Smith farm, about 1,000 feet from Taunton Avenue.
4. A small spring north of the box shop of A. H. Sweet & Son.

In response to this application, the Board has caused the sources of supply to be examined by its engineer and samples of the waters of the first three springs indicated to be analyzed.

The results show that the water of the Cook Spring has been polluted somewhat, probably from the farm buildings on the slope above it; but water of good quality for drinking and other domestic purposes could be obtained from either of the other sources. Neither of the first three sources, however, would, in the opinion of the Board, furnish enough water for the requirements of the village, even if developed to the fullest capacity practicable.

No spring was found near the factory of A. H. Sweet & Son from which it was practicable to obtain a sample of water for analysis. The surface soil in the valley of the brook above this factory consists in places of fine gravel and sand, and it is possible that water may be obtained in considerable quantity from the ground in this region by means of tubular wells or other suitable works; but tests will be necessary before the practicability of obtaining a supply of water for Norton in this region can be definitely ascertained.

The most favorable place from which to obtain water for the supply of Norton is the region of Lincoln Springs, so called, about one and one-half miles south of the village; and there is practically no doubt, in the opinion of the Board, that an ample supply of excellent water for all the requirements of Norton can be obtained from wells or other suitable works in this locality.

In case you should decide to make further tests in the valley of the brook above the factory of A. H. Sweet & Son the Board will assist you by making the necessary analyses of water, and will give you further advice when the results of the tests are available.

## Norwood.

Feb. 1, 1906.

*To the Board of Water Commissioners of the Town of Norwood.*

Gentlemen: — The State Board of Health has considered your application for advice as to taking water for the supply of the town of Norwood from the ground on the southwesterly side of Purgatory Brook, about half a mile southeast of the Ellis station on the Midland Division of the New York, New Haven & Hartford Railroad, and has caused the locality to be examined by its engineer and considered the results of a pumping test made to ascertain the probable quantity and quality of water obtainable from the ground in this region.

The wells which were used in making the pumping test were nine in number, and were located in the meadow, close to the upland. The depth of peaty soil at the surface of the ground in this location is not great, and beneath the surface soil the wells penetrated a coarse sand, from which water could be drawn very freely.

The results of the test, during which about 485,000 gallons per day were drawn from the wells, indicate that a sufficient supply of water for Norwood can probably be obtained from the ground in this region. Samples of water collected daily during the test show that the water is clear, colorless and in other respects of good quality for the purposes of a public water supply; but the quantity of chlorine present is considerably higher than that of normal waters in this region, and the nitrates are also high, — conditions which are doubtless caused by the presence of dwelling houses and a group of farm buildings upon the sandy and gravelly lands northwest of the wells and by the cultivation of these lands. The quantity of iron also is somewhat higher than is found in good ground waters. It is probable, however, that by removing the sources of pollution nearest the wells the danger of serious pollution of the water could be prevented; and it is likely that by locating the wells in the hard land, instead of in the meadow, danger of trouble from an excess of iron in the water could be avoided.

While this test indicates that a sufficient supply of water for the present requirements of Norwood could probably be obtained from the ground in this region by means of a system of tubular wells, and, while it is possible that by removing certain sources of pollution and changing somewhat the location of the wells the quality of the water would be satisfactory, an examination of the locality shows that the conditions are more favorable for obtaining water free from pollution on the opposite, or northeasterly, side of the Purgatory Brook valley, from a quarter to half a mile east of the present wells. So far as can be judged from surface indications, the soil in this region is coarse and porous, and it is probable that water can be obtained from the ground here freely by means of wells or other suitable works.

In the opinion of the Board, it is very desirable that tests be made in this locality before deciding upon the final location of the works; and, if water of good quality can be obtained from the ground in sufficient quantity at some point at least 100 feet away from the edge of the meadow, it would be best to locate the works here, rather than at the place now proposed.

The Board would, therefore, advise a further test in the locality indicated, and will give you further advice, if you so request, when the results of further tests are available.

## Oxford.

Sept. 6, 1906.

*To the Oxford Water Company*, Mr. A. M. Chaffee, *President*.

Gentlemen: — The State Board of Health has considered your application for advice as to a proposed water supply for Oxford, to be taken from the ground at a place about 500 feet west of the Worcester road and 500 feet north of Kidder Brook, so called, in Oxford, and has caused the locality to be examined by its engineer and samples of water from certain test wells in this locality, collected during the pumping test between August 18 and August 22, to be analyzed.

The results of the analyses show that the water is of good quality for all the purposes of a public water supply.

It appears that the test wells from which water was pumped during this test range from 19 to 24 feet in depth, and that all were driven to ledge penetrating very coarse and porous material, from which water could be drawn with great freedom. Information submitted to the Board shows that about 500,000 gallons of water per day were drawn from these wells continuously during the test, and that this draft did not lower materially the ground-water level in the neighborhood of the wells.

These conditions indicate that it is practicable to obtain an ample supply of water for the present requirements of the town of Oxford from wells in this locality.

The Board, acting under the provisions of chapter 193 of the Acts of the year 1904, hereby approves the taking of water for the supply of the town of Oxford from the ground at the place where the test wells used in the recent pumping test are located, — about 500 feet north of Kidder Brook and about the same distance west of the Worcester road.

The Board would advise that, in order to protect the purity of the supply, the water company secure control of a sufficient area of land about the wells and between them and the highway to prevent the construction of buildings along the highway or elsewhere in the vicinity of the wells.

## Palmer (Town Farm).

March 1, 1906.

*To the Board of Overseers of the Poor, Palmer, Mass.*, Mr. Louis E. Chandler, *Chairman*.

Gentlemen: — In accordance with your request of January 29, the State Board of Health has caused an examination to be made of the water of Thompson's Pond and of a small pond on the town farm property, which you state you are considering as possible sources of water supply for the new almshouse, and has caused samples of the waters of these sources to be analyzed.

Thompson's Pond would yield an ample quantity of water for the requirements of the almshouse and buildings; but the analysis shows that the water is highly colored and contains a large quantity of organic matter, which would doubtless make it objectionable for drinking and some other purposes.

The small pond near the present buildings is exposed to danger of pollution from the barn, and would not, in the opinion of the Board, be a safe source of water supply for the institution.

The soil in the region about the new almshouse appears to be coarse and porous, judging from surface indications, and the conditions are apparently favorable for obtaining water freely from the ground. If it is impracticable to obtain enough good water from any existing spring or well in this region, it is probable, in the opinion of the Board, that, by sinking a well at some point in this neighborhood where the ground water is not likely to be affected by sewage or drainage from buildings, enough water of good quality for the requirements of the institution can be obtained. The best plan of making an investigation as to the practicability of obtaining a supply in this way would be to drive small tubular test wells to a depth of not more than 40 feet at some point or points where the conditions appear to be favorable; and when a location is found where good water can be obtained freely from a test well, either additional tubular wells or a large well can be put in, as seems best suited to the conditions. The Board will assist you in further investigations, if you so request, by analyzing samples of water from test wells or other sources from which it may be practicable to obtain a suitable water supply.

## PITTSFIELD.

Nov. 1, 1906.

*To the Board of Public Works of the City of Pittsfield.*

GENTLEMEN:—The State Board of Health has considered your application for advice with reference to constructing a reservoir on Sacket Brook at the Crocker place, so called, and the plans presented in connection therewith, and has caused the locality to be examined by its engineer.

The plans provide for the construction of a reservoir at the point indicated which will have a capacity of about 200,000,000 gallons and a water-shed of .45 of a square mile. There appears to be no serious difficulty in the construction of a reservoir at this place; but, if constructed, it should be thoroughly prepared for the storage of water by the removal of the stumps and soil containing organic matter from the area to be flowed, or by covering the peaty soil, in the places where its depth is considerable, with sand or gravel.

No records of the consumption of water by the city are available, but from the estimates presented by your engineer it is probable that the quantity of water now used amounts to as much as 100 gallons per person per day, and is equal to, if not in excess of, the capacity of the present sources in a dry season, so that, in the opinion of the Board, an additional supply should be furnished without delay. The amount of increase in the capacity of the present sources of water supply that would be obtained by the construction of the proposed new reservoir, however, is probably less than 20 per cent.; and it is evident that if this reservoir should be constructed a further additional supply would, at the present rate of growth of the city, very soon become necessary.

No definite plans for the further increase of your water supply, after the capacity of the present sources, with the addition of the proposed new reservoir, has been reached, appear to have been prepared; though studies made by your engineers in connection with plans for increasing the pressure in the city show that reservoirs might be constructed on the brooks now used above the present intake reservoirs on those streams, which would hold in the aggregate possibly 100,000,000 gallons.

The construction of these reservoirs, if it should be found practicable to build reservoirs of the capacity indicated, would probably increase the yield of the present sources considerably more than the construction of the proposed reservoir on Sacket Brook at the Crocker place; and in connection with such a plan of development a material increase could be made in the pressure upon the mains in the city.

Judging from the information now available, it appears to the Board that this plan will be a better method of beginning the further development of your supply than the plan of constructing in the beginning the proposed storage reservoir at the Crocker place. It is evident that the increase in the yield of the brooks that it will be practicable to secure by the plan of constructing new reservoirs on each stream, as suggested, is a limited one, and that a further additional supply for the city would again become necessary in a few years, if its growth continues as in the past. The yield of the brooks might then be further enlarged by constructing a reservoir on Sacket Brook or on Ashley Brook, where there is apparently a good opportunity for the construction of a storage reservoir about a mile below Ashley Lake; but it is possible that a greater increase in the supply might be secured at less expense by taking water from some other source.

Of the sources from which it is possible to take an additional supply for Pittsfield, the one most easily made available is Roaring Brook, the water-shed of which is contiguous to that of Mill Brook on the south. This source has been considered in past years, but, owing to the high

color and objectionable character of the water at the point at which this stream could be diverted into Mill Brook, its use has not been considered advisable. A further examination of the possibility of utilizing this brook shows that it may be practicable, by means of a canal or conduit, to intercept the tributaries of the brook, and of Clapp, or Mud, Pond, situated near the upper end of the brook, the waters of which appear to be of much better quality than that of the main brook or the pond, and convey this water into the water-shed of Mill Brook by gravity, and in this way increase the area of water-shed available for the supply of the city by about 3 square miles. It also appears to be possible to construct upon the branch of Mill Brook, into which this water would naturally be discharged, a storage reservoir of a capacity of perhaps 100,000,000 gallons; and if this should be found to be the case, a very material addition to the water supply of Pittsfield might be obtained by this plan, at reasonable expense.

Considering the circumstances, the Board does not at present recommend the construction of the proposed storage reservoir on Sacket Brook at the Crocker place; but would recommend that you consider more carefully the plan of building reservoirs of as large capacity as practicable as nearly as possible at the sites of the present intake reservoirs, securing at the same time such an increase in pressure upon the mains in the city as may be deemed possible and desirable under the existing conditions. The Board would also recommend that you investigate the practicability of obtaining a further additional supply by diverting the water from a part of the water-shed of Roaring Brook into Mill Brook, and the possibility of constructing a storage reservoir of considerable size on the latter stream for use in connection with this plan. When you have made further investigations the Board will, upon application, give you further advice as to enlarging your water supply.

## Plymouth.

Dec. 12, 1906.

*To the Board of Water Commissioners of the Town of Plymouth.*

Gentlemen: — The State Board of Health received from you on Nov. 22, 1906, an application for advice as to an additional water supply for the town of Plymouth, stating that it is proposed to investigate (1) an underground supply, (2) Billington Sea, and (3) Long and Halfway ponds.

It appears that the plan for obtaining a ground-water supply is with the view of supplying manufacturing concerns, which use a large quantity of water. The other sources, if used, would be connected directly with your present works.

The Board, in response to this application, has caused the locality to be examined by its engineer and has considered the information presented as to the capacity of the present sources of supply, the need of an additional supply and the quality of the water of the various sources available.

The locality indicated as a possible source of ground-water supply is the valley of Town Brook, in the lower part of its course in the town. While it is probable that a large quantity of water could be obtained from wells or filter-galleries there, the ground water of this locality is undoubtedly polluted by the dense population living on the territory about it; and it is not desirable, in the opinion of the Board, for the town to supply such water where it might be accessible for drinking.

If it should be deemed desirable to introduce a supply of ground water for the use of the manufacturing establishments, it is probable that water of good quality could be obtained by sinking wells at some place in the uninhabited territory immediately back of the thickly settled portions of the town; and there are several localities there in which the conditions appear to be favorable for obtaining a large supply of good ground water. Such water might be introduced into the general water supply system of the town, if found desirable; but it would be necessary to avoid discharging any ground water into the open distributing reservoirs, where it would be likely to cause trouble from growths of organisms and disagreeable tastes and odors. It is probable that a considerable amount of ground water could be introduced into the supply mains, however, without danger that it would reach the reservoirs.

Billington Sea, the second source of supply mentioned, lies at no great distance from Lout Pond, one of the sources now used; and, since it appears that the former pond is somewhat higher, it is probable that a large additional supply could be obtained by diverting its waters into Lout Pond. The water of Billington Sea, judging from the results of a single analysis, is of good quality for domestic purposes, and there is no doubt that that source would furnish a very large additional water supply; but it is one of the chief reservoirs which feed Town Brook, on which there are several factories which use the water for power, and the cost of taking a supply from that source would doubtless be large.

Long and Halfway ponds are probably considerably lower in level than your present sources of supply, and are at such a long distance therefrom that the cost of taking water from either of those sources would also be large.

With the present arrangement of your water works, the depth of water that can be drawn from Little South Pond is limited to less than 4½ feet below full pond, this being the approximate level of the sill of the

screen well. Great South Pond is connected with Little South Pond by an artificial channel, constructed many years ago. This channel at one time filled with sand, and was reconstructed a few years ago at a lower level; but it appears that the channel is again becoming partially stopped up, and at the present time the water in Great South Pond is nearly 1½ feet higher than in Little South Pond.

Boot Pond, lying south of Great South Pond, and separated from the latter only by a narrow strip of sandy land, is at present at an elevation of about .75 of a foot higher than Great South Pond, but is not directly connected therewith, though such a connection could apparently be made at small expense.

With the intake works at Little South Pond arranged as at present, it is impracticable to use all of the storage in this source that might be used; and, on account of the clogging of the channel between Great and Little South ponds, a large part of the storage in Great South Pond is not at present available, and, under present conditions, it is doubtful whether these ponds and Lout Pond together will yield more than about 1,000,000 gallons of water per day.

With a suitable connection between Little South and Great South ponds and a similar connection between Boot and Great South ponds, a much larger daily yield could be obtained from these sources without other material changes in the works, — possibly a yield as great as 1,500,000 gallons per day, including Lout Pond. It would be practicable to obtain a greater yield, possibly as much as 2,000,000 gallons per day, from these four ponds, if provision should be made for drawing the water to a much lower level. This could apparently be done by providing a comparatively inexpensive pumping plant at Little South Pond and the necessary appurtenances to raise the water into the conduits leading to the pumping station, and by providing the necessary channels or other means of drawing down the water in Great South and Boot ponds.

The only definite information indicating the consumption of water in Plymouth is the result of observations made during two periods in the years 1905 and 1906, one period being in the month of August, 1905, and the other in the month of January, 1906. The results of these observations show that the consumption of water in the former case was 1,200,000 gallons per day, and in the latter about 950,000 gallons per day. If these measurements are fairly representative, they indicate that the quantity of water now used in Plymouth is excessive, even allowing for the use of a large quantity of water by manufacturing establishments.

The policy of measuring all of the water supplied by the town, which the Board is informed you are about to inaugurate by placing large meters

on the mains, is a most important step toward the prevention of waste of water.

Even if the consumption of water is as great as is indicated by the observations mentioned above, the Board is of the opinion that the present sources of supply, including Boot Pond, are adequate to provide all of the water required for the present needs of the town, if provision shall be made for making available a greater portion of the storage in the ponds than is practicable with the works as now arranged.

The Board would recommend that you make investigations to determine the best practicable plan of securing a greater yield of water from your present sources of supply, including Boot Pond, and will give you further advice as to increasing your water supply when you have the results of further investigations to present.

## Provincetown.

Nov. 1, 1906.

*To the Water Commissioners of the Town of Provincetown.*

Gentlemen: — The State Board of Health received from you on Feb. 9, 1906, a communication giving notice of your intention to make experiments as to improving the quality of the water supply of Provincetown, which is objectionable on account of the presence of an excessive quantity of iron, and requesting the co-operation of the Board in carrying out the experiments, and advice as to the best method of purifying the water. A plan of the proposed tanks and filters was submitted with the application, and the experiments have been carried on nearly up to the present time.

The water supply of Provincetown, as originally drawn from a system of tubular wells and subsequently from an open basin, located about three-quarters of a mile north of the village, has always been affected by an excessive quantity of iron, which makes it very objectionable for many domestic uses, and the experiments have been directed toward the removal of the iron from the water.

The Board has considered the results of these and previous experiments and of the numerous analyses of the water supplied to Provincetown from the present sources, as well as the results of investigations made with a view to obtaining a supply from other sources.

Two methods of treating this water for the removal of the excess of iron have been tried. The first is to bring the water into contact with metallic iron, when, if the water acts readily upon the iron, an additional quantity of this substance may be taken up by the water, which, together with the iron and organic matter originally present in the water, separates readily, and can then be removed by filtration through sand.

The success of this method appears to be dependent chiefly upon the quantity of carbonic acid present in the water to be treated.

The Provincetown water does not always act sufficiently upon the metallic iron with which it is brought in contact to bring about the result desired, though the indications are that if water from the tubular wells only should be used a satisfactory purification of the water could be effected by this treatment.

Another method of purifying this water is by the application of aluminum sulphate, which causes the iron to separate from the water, so that it can practically all be removed by the subsequent filtration of the water through sand. There is no doubt that by this method the iron can be successfully removed from the Provincetown water. The objections to the use of this method are that the hardness of the water may be increased and that an excessive quantity of the chemical may be used, so that undecomposed aluminum sulphate may be present in the water supplied to consumers. With sufficient care in the operation of the filters, the presence of alum in the filtered water can be prevented.

The estimated cost of a purifying plant to purify the water by this plan, as given by your engineer, is about $13,000, and the annual cost entailed by the necessary extra pumping, chemicals and maintenance of the filters is $1,345. No estimate of the cost of purifying the water by the use of iron has been presented, but it would probably not differ greatly from these estimates.

An investigation has also been made during the past year with a view to the possibility of obtaining a water supply for the town from some source likely to furnish naturally a water of good quality. The information furnished by test wells sunk in various places in the neighborhood of the village indicates that it will be impracticable to obtain water of better quality from any place in this region than is now obtained from the present wells. East of Provincetown, however, in the higher lands beyond Moon Pond Meadow and Salt Meadow, in the town of Truro, the character of the soil appears to be very different from that which is found in the neighborhood of Provincetown; and the results of analyses of water from several wells in this region indicate that water of good quality, free from an excess of iron, can probably be obtained from the ground within about 4½ miles of the village.

Estimates made by your engineer indicate that the cost of necessary works for taking a supply of water from this region would not exceed $45,000, and that, if the present pumping machinery should be used, the cost might be somewhat less than that amount. Moreover, a pipe line from the direction of Truro will serve a considerable number of houses at the easterly end of Provincetown village not now reached by

the present pipe line, but to serve which an extension of the pipe line will doubtless soon have to be made, especially if a water of good quality should be introduced.

Comparing the probable cost of the construction and maintenance of filters with the cost of constructing and maintaining works for taking water from the ground about 4½ miles east of the village, it appears that the annual cost of a new supply is unlikely to be much, if any, greater, all things considered, than the cost of purifying the present supply; and in the long run the cost of the new supply would doubtless be much less than the cost of purifying the water of the present sources or of any other source in the immediate neighborhood of the village.

Under these circumstances, it is likely to be for the best interests of Provincetown to abandon the present supply and take a new supply from the ground in the direction of North Truro, if a sufficient supply of good water can be obtained from the ground in that region; and the Board would recommend that you put in a number of test wells in the region indicated, and make a pumping test, by connecting them to a steam pump and pumping from them for a period of at least two weeks, to determine the probable yield of the source and the quality of the water.

The Board will assist you in the investigations, if you so request, by making the necessary analyses of the water, and will give you further advice when the results of such a test are available.

## Rutland (Industrial Camp).

July 5, 1906.

*To the Board of Prison Commissioners,* Mr. Frederick G. Pettigrove, *Chairman.*

Gentlemen:—In accordance with your request for advice as to a proposed water supply for the industrial camp at Rutland, to be taken from the ground along the Ware River near the camp, the Board has caused the locality to be examined by one of its engineers and samples of water from test wells to be analyzed.

Two of the three test wells thus far driven are located on the westerly side of the river, opposite the camp and south of the junction of the two branches of the Ware River. A sample of water from one of these wells, which furnished water quite freely, was found to contain iron in such quantity that it would be objectionable for many uses, while from the other well no water could be obtained. The third test well is located in a meadow bordering the easterly side of the main stream, opposite the camp and a short distance below the point where the stream is joined by the easterly branch. This well was driven to a depth of about 30 feet, penetrating a stratum of coarse material from which water could be obtained very freely, and the results of an analysis show that this water is of excellent quality for water-supply purposes.

There appear to be no sources of possible pollution of the ground water in this neighborhood; and, in the opinion of the Board, while the information furnished by the tests thus far made is not conclusive, the indications are that a sufficient supply of good water for the requirements of the camp and hospital can be obtained from the ground in the vicinity of this test well.

### Salem and Beverly.

June 7, 1906.

*To the Salem Water Board, Mr.* Edward N. Reed, *Chairman, Salem, Mass.*

Gentlemen: — The State Board of Health received from you on Nov. 17, 1905, an application for advice with reference to increasing and improving the water supply of Salem and Beverly, stating that various possible sources of supply were being investigated, and requesting the co-operation of the Board in the examination of certain waters then under consideration. The results of the investigations were subsequently presented by your engineer in two reports, in which various plans are considered and the following recommendations are made: —

I recommend as the best, most efficient and economical plan for improving and increasing the water supply of Salem and Beverly, the filtration at Wenham Lake of the present supply as described in the foregoing report. This is the only plan that is at once sufficient for the needs of the near future, best adapted for combination with a further additional supply, surely available and satisfactory, free from chance of water damage suits and suits for rights of way and needing no legislation to enable you to take water or land.

I also recommend that before final plans are made for this work an experimental filtration plant be installed in or near one of the pumping stations where tests may be made to determine the best arrangement of the sand filter plant for the treatment of this particular water. This experimental plant should be designed to ascertain the effect of aeration, single and double filtration, different depths of sand, rates of filtration, etc.

The information obtained in this way will undoubtedly save much more than its cost in the actual construction of the filters, if indeed it does not prevent mistakes in the general design.

Tests should also be made to ascertain the effect of storing filtered water in the light. The results of these tests will aid in the determination of the question whether or not the reservoirs should be covered. . . .

I estimate that the cost of the experimental work will be from $2,000 to $3,000.

To properly present the entire subject I believe that the following statement should be made. The plan for a ground water supply in the Miles River valley provides for a supply of the same quantity at much smaller cost for construction or for annual maintenance in case a suitable water in sufficient quantity is found.

It is not made clear by the preliminary tests whether or not the water will be of satisfactory quality, even if a sufficient quantity is found. As already estimated, it will cost from $5,000 to $8,000 to determine both questions, with the possibility, if not the probability, that the results will be against the plan in respect to the quantity of iron in the water.

There are some reasons already indicated why the filtration plan will be on the whole more satisfactory than the ground water plan, even if the supply in the latter proves to be sufficient. I feel that, under the circumstances, it is not my province to recommend that the ground water tests be made, but rather that it is for you to decide if the possible economy of such a supply warrants the expenditure which is required to determine whether the supply is or is not available. If you should decide that the test be made, it can be carried on coincidently with the filtration experiments, and the final decision made when the results are determined.

The plan includes a provision for drawing the water of Wenham Lake to a level 30 feet below high water if necessary, and for diverting into the lake or into Longham Reservoir the water from the water-shed of Beaver and Norwood's ponds, thus increasing the capacity of the works to about 6,000,000 gallons per day in a dry season, or about 30 per cent. more than the quantity of water used during the year 1905, which appears to have been 4,657,000 gallons per day. The question of a further additional supply after the capacity of the works developed as suggested has been reached is also considered; and the results of a general examination, showing the practicability of supplementing the supply from the Ipswich River or some of its tributaries, or from the works of the Metropolitan Water District, are presented.

The Board has carefully considered the reports presented, the results of the analyses of samples of the water of test wells in the valley of Miles River and the information available as to the capacity of the present sources of supply, the character of their waters and the means proposed for their improvement.

The water of Longham Brook has a high color and contains a large quantity of organic matter, due to its slow passage through the extensive swamps and meadows on the water-shed; and the water deteriorates still further after storage in the Longham Reservoir, a shallow basin, the bottom of which is covered with mud. While the mud could be removed from the bottom of the reservoir, the investigations of your engineer show that it will not be practicable to drain thoroughly the swamps within the water-shed, and the improvement in the quality of the water obtainable by this means is probably insufficient to warrant the outlay.

The water of Wenham Lake, up to the time of the introduction of

the supplementary supply from Longham Reservoir, was usually nearly colorless and of excellent quality for all the purposes of a public water supply, and had rarely, if ever, during the time of its use for the supply of Salem and Beverly, been affected by disagreeable tastes or odors. Upon the introduction of the water of Longham Reservoir into the lake the color and quantity of organic matter in the lake water increased decidedly, and have remained much higher in the years since Longham water was introduced than previously. During the past year (1905) a larger quantity of water than usual has been diverted from Longham Reservoir into Wenham Lake, and the quantity of organic matter present in the lake water has been higher than ever before.

The water of Beaver and Norwood's ponds, proposed as an additional source of supply, is also highly colored and resembles closely the water of Longham Reservoir; and investigations indicate that it would not be practicable to improve the quality of the water of this source by cleaning the ponds or making other improvements in the water-shed.

Under the circumstances, if the discharge of the waters of Longham Brook into Wenham Lake is to be continued, the Beaver and Norwood's pond sources subsequently added and large quantities of water from these sources diverted into the lake, as will be necessary in the future if the supply of the two cities is to be obtained wholly from these sources, the quality of the water of the lake is likely to continue to deteriorate and to be objectionable for domestic uses.

It is probable that the water of the lake could be efficiently purified by filtration through sand, the color of the water decreased and objectionable tastes and odors removed so that the water would be satisfactory for domestic purposes.

The water of Wenham Lake, before the introduction of water from Longham Reservoir, as already stated, had very little color and was of good quality for all the purposes of a public water supply. If the discharge of water from Longham Reservoir into the lake should be discontinued, the quality of the water of the latter source would, without doubt, improve materially and very likely become again as satisfactory as in the earlier years. It would be necessary, however, in order to obtain a sufficient supply of water for the cities, either to purify the water of the Longham Reservoir and of Beaver and Norwood's ponds or to obtain an additional supply from some other source.

The water of Longham Reservoir and of Beaver and Norwood's ponds could probably be purified by filtration through artificial sand filters, as suggested; but, after purification, the water would probably still have considerable color and be objectionable on this account if supplied directly to consumers.

Another method of improving the quality of the water from these sources would be to apply it intermittently to natural beds of sand or gravel, — of which there appear to be large areas available for the purpose in the neighborhood of Wenham Lake, — allowing the effluent from the filters to flow directly into the lake; and it is probable that by discontinuing the direct discharge of water from Longham Reservoir into Wenham Lake, and allowing it to enter the lake only after filtration through the soil, the water of the lake would be of good quality at all times.

The investigations of your engineer show that the only other surface-water sources from which it is practicable to secure a large additional supply, aside from the sources now used by other municipalities, are the Ipswich River and its tributaries; but the waters of the river itself and of the available tributaries are also very highly colored and contain large quantities of organic matter and resemble very closely the waters of Longham Brook and Beaver and Norwood's ponds, and there does not appear to be any better plan of supplementing Wenham Lake at the present time than by using the water of the latter sources.

The results of the limited number of tests made with a view to obtaining a ground-water supply in the valley of the Miles River in the neighborhood of the outlet of Wenham Lake are, on the whole, unfavorable to obtaining a considerable supply of good ground water in this locality; and it is doubtful, judging from these tests, whether a sufficient additional supply of ground water unaffected by an excessive quantity of iron could be obtained from works in this valley to make it practicable to dispense with the use of Longham Reservoir or other surface sources in connection with Wenham Lake.

In the opinion of the Board, there is some question as to whether the turning of the water of Longham Reservoir and Beaver and Norwood's ponds into Wenham Lake and then filtering the mixed water would give as satisfactory a supply to consumers as the removal of organic matter and color from the water of these colored sources by filtration through the ground before entering Wenham Lake.

The Board would recommend that investigations and tests be made to determine the area best suited for purifying the water of Longham Reservoir and Beaver and Norwood's ponds, and that a plan be prepared for delivering the water of these sources upon the area selected in such a manner that the water will filter through a considerable depth of gravelly soil and remove much of the organic matter and color before entering Wenham Lake.

When the investigations have been made and the plans and estimates of cost prepared, the Board will give you further advice in the matter, if you so request.

### SALEM AND BEVERLY — AMENDMENT OF RULES AND REGULATIONS.

The rules and regulations adopted by the Board on Dec. 6, 1900, for the sanitary protection of the water supply of the city of Salem, were amended by the Board on July 5, 1906, so as to provide for the regulation of boating, fishing, ice cutting, etc., thereafter by the State Board of Health, instead of the local water board.

### SHARON.

JAN. 4, 1906.

*To the Board of Water Commissioners of the Town of Sharon.*

GENTLEMEN: — The State Board of Health received from you on Dec. 4, 1905, the following communication relative to taking lands for the protection of the water supply of the town: —

In accordance with the views expressed in letters of advice from the State Board of Health to the joint committee on increased water supply of the town of Sharon, bearing date of March 5, 1903, and June 4, 1903, and in accordance with the unanimous vote of the board of water commissioners of said town, said board acting under the authority in them vested by chapter 177 of the Acts of 1883 and chapter 241 of the Acts of 1894, did, upon the twenty-eighth day of April last, enter upon and take possession of certain lands and rights therein, in behalf of said town of Sharon, for the purpose of providing an increased water supply for said town, holding and preserving the same, and conveying water to the streets thereof, also the right to withdraw water from all springs and subterranean waters in said land.

We therefore ask your Board to view the lands so taken, as shown upon the accompanying map, and to consent to the taking of water for domestic purposes from these lands and to make such examination of said lands and the waters thereof as may be necessary to advise our board as to the acts necessary to insure the preservation and purity of such water supply.

The application is accompanied by plans showing lands taken by the town in the valley of Beaver Hole Meadow Brook above the present sources of water supply.

In response to the application, the Board has caused the present sources of supply to be examined by its engineer and has also caused an examination to be made of the lands indicated upon the plan submitted.

In the communications of the Board to the joint committee on water supply of the town of Sharon, referred to above, the Board expressed no views regarding the taking of lands, but advised that tests should first be made in the valley of Beaver Hole Meadow Brook above your present wells with a view to obtaining a ground-water supply in that region.

The wells from which the water supply of Sharon is now being drawn

proved inadequate for the supply of the town during the past summer, and it appears that an auxiliary supply has been obtained by drawing water directly from Beaver Hole Meadow Brook. In the communication addressed to your board under date of March 5, 1903, the State Board of Health expressed the opinion that this brook is an unsafe source from which to take water directly for drinking or other domestic purposes, and advised that tests be made with a view to obtaining an adequate supply of water for the town in the valley of the brook above the wells. In a subsequent communication, dated June 4, 1903, the Board again advised that you make a test in the valley of Beaver Brook above your present wells to determine the practicability of obtaining an adequate supply of good water from the ground in this region.

It appears that no tests have thus far been made in the region indicated or elsewhere, and the Board has no means of determining definitely whether the necessary quantity of ground water can be obtained in this region, or its probable quality. Under the circumstances, the Board is unable to advise you as to the protection of a water supply in this region or to consent at present to the taking of a supply here. The Board would again advise that you make tests in the valley of the brook above your present wells, and when the results of investigations are available will give the matter further consideration.

AUG. 13, 1906.

*To the Committee on Water Supply of the Town of Sharon,* MR. WILLIAM L. HASKEL, *Secretary.*

GENTLEMEN: — The State Board of Health has considered your communication relative to the water supply of Sharon and the report of your engineer submitted therewith, and has caused the location of certain test wells driven in the valley of Beaver Hole Meadow Brook to be examined by its engineer and samples of water sent in by you from two of the wells, located respectively 800 feet and 3,000 feet above your pumping station, to be analyzed.

The results of the analyses show that the water of the test well located about 800 feet above the pumping station, while of somewhat better quality than that of your present sources of supply, has a higher chlorine than is found in normal waters in this region and shows other evidences of previous pollution. The water of the well 3,000 feet above the pumping station is of good quality and unaffected by sewage pollution. It is understood that this well yielded water freely when pumping with a hand pump; and, judging from the information as to the character of the soil penetrated, it is probable that a sufficient supply of water for all the requirements of the town can be obtained from the ground in this locality.

In order to determine definitely the probable quantity and quality of the water to be obtained here, it will be necessary to make a further test

by putting in a group of wells, connecting them with a steam pump and pumping from them for at least a week at a rate such as would be necessary for the supply of the town. The variation in the level of the ground water about the wells should be observed during the test, and samples of water should be collected for analysis at frequent intervals to determine its quality. When the results of such a test are available, it will be possible to determine whether it is practicable for the town to obtain a sufficient supply of good water from the ground in this locality.

It is possible that a supply of good water can be obtained at a point nearer the pumping station, and the conditions appear to be favorable for obtaining such a supply in the neighborhood of the bridge over the brook, 1,800 feet to 2,000 feet above the pumping station. If tests should show that good water could be obtained in that locality, a saving might be effected in the cost of the works; and under the circumstances the Board would recommend, as the next step in your investigations, that you cause test wells to be driven in the neighborhood of the bridge mentioned and samples of the water to be analyzed. If further tests should show that good water can be obtained freely from the ground in that locality, it would probably be best to locate the works there rather than at the point above.

The Board will, upon application, assist you in further investigations by making the necessary analyses of water, and will give you further advice when the results of further tests are available.

DEC. 6, 1906.

*To the Committee on Water Supply of the Town of Sharon, Mr.* WILLIAM L. HASKEL, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on Nov. 28, 1906, a communication stating that, in compliance with its recommendation of Aug. 13, 1906, you have had three additional wells driven in the vicinity of the bridge over Beaver Hole Meadow Brook, referred to in that communication, — two being above the bridge and one below, all yielding a fair amount of water, — and requesting advice as to the quality of the water therefrom; and in response to this communication the Board has caused the locality to be examined by its engineer and samples of water from the three test wells in the locality indicated to be analyzed.

The results of the analyses show that the water of these wells, like those located farther down the valley and examined last summer, has a higher chlorine than is found in normal waters of this region, and show also other evidences of previous pollution, indicating that it is improbable that water of good quality can be obtained from this valley without going farther up stream.

The Board would now recommend that you put in additional wells in

the region of the extreme upper test well, about 3,000 feet above the pumping station, and make a pumping test, in the manner recommended by the Board in the communication of August 13, by putting in a group of wells in the locality indicated, connecting them with a steam pump and pumping from them for at least a week and at a rate such as would be necessary for the supply of the town.

The Board will assist you in making this test by making the necessary analyses of water, if notice is received of the time when the test is about to begin, and will give you further advice when the results of the test are available.

### Southbridge.

Sept. 6, 1906.

*To the Southbridge Water Company, Southbridge, Mass.*

Gentlemen: — Complaint has been made to this Board of the objectionable quality of the water supplied recently to the town of Southbridge from the works of the Southbridge Water Company, and the Board has caused an examination of the sources of supply to be made by its engineer.

It appears from this examination that the objectionable condition of the water was probably caused by the flooding of the bottom of the new storage reservoir on Hatchet Brook early in the present year. The area to be flowed by this reservoir has not yet been properly prepared for the storage of water and contains numerous stumps and large quantities of peaty soil, from which the water evidently took up an excessive quantity of organic matter. It is understood that the work of construction of this reservoir has not yet been fully completed; and the Board would advise that no more water be stored in this basin until it has been thoroughly prepared for the purpose by the removal of the stumps, soil and other organic matter, as advised by the Board in the communication dated June 29, 1905, a copy of which is attached hereto.

### South Hadley.

Aug. 2, 1906.

*To the Board of Water Commissioners of Fire District No. 1 of the Town of South Hadley.*

Gentlemen: — The State Board of Health received from you on July 9, 1906, an application for advice as to a proposed plan of preventing the pollution of Buttery Brook, one of the sources of water supply of South Hadley; and subsequently two plans were submitted, one showing the location of the various dwelling houses, barns and out-buildings from which the brook is polluted, and the other a plan designed to remedy the objectionable conditions which now exist.

In response to this application, the Board has caused the locality to be examined by its engineer and has considered the plans and informa-

tion presented. While the limits of the water-shed of Buttery Brook are somewhat indefinite, an examination shows that a large portion of the settlement known as Fairview is situated in the valley of the brook, and that many privies and sink drains are located in close proximity to the stream or its tributaries. The remedy proposed for these objectionable conditions is to lay a pipe to take the flow of the brook from the outlet of the extensive swamp just above Fairview, in which Buttery Brook takes its rise, to a point below Abbey Street, and to fill the brook in the region through which the pipe line passes with sand or gravel.

While the soil in the valley of Buttery Brook below the swamp at the upper end of its water-shed is sandy and porous to a considerable depth, it is very doubtful whether all of the water falling upon this portion of the water-shed would filter through the ground to the stream below Fairview; and it is improbable in any case that many of the more objectionable pollutions in the valley of this brook could be eliminated in this way.

It is impracticable, in the opinion of the Board, to protect this source adequately either by the construction of a sewerage system or by the enforcement of sanitary rules and regulations, unless many of the dwelling houses and out-buildings nearest the brook or its feeders should be removed.

While the value of many of these places may be comparatively small, the aggregate cost to the district of acquiring a sufficient number of them to prevent the further pollution of the brook would probably be large.

In the opinion of the Board, the most efficient method of obtaining from this source water which will be safe for drinking will be to filter it through sand. It appears that the pressure under which water is now supplied to the district is already less than desirable, and, under the circumstances, it will probably be necessary to locate the filters above the present reservoir. While the cost of the construction and the efficient maintenance and operation of suitable filters will be large, there does not appear to the Board any other practicable way of securing from this source water which will be safe for drinking.

It may be practicable to obtain a new source of supply which will furnish water of good quality at less expense than would be required to purify the water of Buttery Brook or render it satisfactory in any other way, and in that case it might be best to discontinue the use of Buttery Brook.

When you have prepared plans for filtering the water of Buttery Brook, the Board will advise you concerning them, if you so request; and, should you decide to investigate other possible sources of supply,

the Board will give you such assistance as it can by making the necessary analyses of the water of available sources.

The Board would advise that you take measures without delay to prevent, so far as possible, the direct pollution of Buttery Brook or any of its feeders, and that a careful supervision of the source be exercised while its use is continued.

### SPENCER (E. JONES AND COMPANY).

FEB. 1, 1906.

To Messrs. E. JONES & Co., *Spencer, Mass.*

GENTLEMEN: — In response to your request of Dec. 15, 1905, for an analysis of the water of a well at your factory in Spencer, which you state is used by the employees and families near by as a source of drinking water, the Board has caused the well and its surroundings to be examined and samples of its water to be analyzed.

It appears, from the information furnished the Board, that the well is 565 feet in depth, all but the upper 10 or 12 feet being in rock.

There are sources of pollution at no great distance from the well, but the results of the analyses, which differ in some respects from those of good ground waters, do not show evidence of serious pollution. Under the circumstances, the Board is unable, from the investigations thus far made, to recommend the use of this water for drinking.

It is understood that the water is used for washing and other purposes in the factory; and the Board will make further analyses from time to time if you will furnish the samples, and will give you further advice as to the quality of the water for drinking when the results of further tests are available.

### SPRINGFIELD.

JAN. 4, 1906.

*To the Board of Water Commissioners of the City of Springfield.*

GENTLEMEN: — The State Board of Health received from you on Nov. 4, 1905, an application for advice with reference to a proposed water supply for the city of Springfield, containing the following outline of your proposed plans: —

On Oct. 30, 1905, the city council of Springfield voted unanimously to petition the legislature for an act to take the waters of Westfield Little River, so called, as a source of water supply for the city of Springfield.

The Westfield Little River is a branch entering the Westfield River just below the village of Westfield.

It is proposed to take the water at some point on that stream which would afford by a gravity flow ample pressure in the city of Springfield. It is proposed to build sufficient storage reservoirs to equalize the flow of the stream sufficiently for the supply of the city of Springfield.

The method of diversion is through a conduit and tunnel to a filter site above West Parish in the town of Westfield, and from thence to the city of Springfield by means of a pipe line.

This plan is outlined in a report by Mr. Allen Hazen, C.E., dated May 1, 1905, printed in pamphlet form and made a part of this application. The charts in this report indicate the comparative elevations and location of the various proposed works and the outline and survey of the proposed main reservoir.

These are not submitted as detailed plans, nor as the adopted means of procedure, but merely as information regarding the possibilities of the development of this water-shed.

The board of water commissioners at the present time desire your advice as to whether this source of supply is a suitable and appropriate one for the city of Springfield.

The Board has caused the water-shed of Little River to be examined by its engineer, and has considered the plan presented and the results of analyses of samples of water from the Westfield Little River collected and sent in by you during the past year.

The results of the analyses of samples of water collected between May 14 and Oct. 1, 1905, and of samples collected in the summer of 1893, show that the water is soft and generally of good quality for the purposes of a public water supply. At times, however, especially after heavy rains, the water is highly colored and contains considerable organic matter derived from swamps on the water-shed.

It is practicable to improve the quality of the water considerably and reduce the color and quantity of organic matter by the drainage of the swamps, and the water would also doubtless improve further upon storage in a properly prepared reservoir. If a reservoir of large capacity should be constructed below the junction of Borden and Pebble brooks, as proposed, and should be prepared for the storage of water by the removal of all the soil and organic matter from the area to be flowed, a water of good quality could without doubt be obtained from this source. The water-shed contains a very small population, but a few buildings are so situated that polluting matters from them are likely to enter the streams at the present time. The source can easily be protected from pollution by purchasing and removing the more objectionable places and by exercising an efficient police control of the water-shed. If the water should be filtered, as suggested, a further reduction in the color and quantity of organic matter could be effected; and, with proper filters, a water of excellent quality could be supplied from this source at all times.

The quantity of water which the proposed source can be developed to yield will depend upon the capacity of storage reservoirs which can be

constructed within its water-shed. There are practicable sites for reservoirs of such capacity that the source can be made to yield enough water for the requirements of the city for a long time in the future, probably for thirty years at least, judging from the present rate of growth and use of water; and when the capacity of the source has been reached it will doubtless be feasible to obtain an additional supply from some of the other water-sheds in this region.

In a communication to your board last year this Board advised the city to make a thorough investigation of the cost of taking a water supply from the East and Middle branches of the Westfield River, as well as from the Westfield Little River. The quality of the water of both the East and Middle branches of the Westfield River is somewhat better than that of the Westfield Little River, and a little larger supply could be obtained from the Middle Branch and a much larger supply from the East Branch than from the Westfield Little River, while the cost of the works, so far as could be judged from the information then available, might be no greater, and possibly less in the case of at least one of these branches, than the cost of works from the Westfield Little River; but it does not appear that a further investigation of these sources has been made.

While it is probable, in the opinion of the Board, that at least one, and probably both, of these sources possess advantages as regards the quantity and quality of water available, and possibly also in the case of one of the sources as to cost, there is no doubt that an ample supply of good water for the requirements of Springfield for many years in the future can be obtained from the Westfield Little River at reasonable cost; and, in the opinion of the Board, this stream is an appropriate source of water supply for the city of Springfield.

In considering the possible needs and interests of other cities and towns in this region with reference to water supply, the Board finds that the Westfield Little River will probably be the most appropriate source from which to supplement the supply of the town of Westfield, when a further supply for that town becomes necessary. It does not appear that any records are kept of the quantity of water now used by the town of Westfield, but, judging from the quantity of water used by similar communities, the present sources of supply of that town are capable of furnishing more than twice the quantity of water now required; and it is practicable to increase further the capacity of the present sources by the construction of an additional reservoir, so that they will be capable of furnishing an ample supply of water for this town for a very long time in the future, probably as long as the Westfield Little River will furnish a sufficient supply of water for the city of Springfield. The Board is of the opinion, however, that the right to the use

of the water from Little River should not be granted to the city of Springfield to the exclusion of the town of Westfield when a further supply of water shall be required by the latter town beyond the capacity of the present sources, reasonably developed.

AUG. 2, 1906.

*To the Board of Water Commissioners of the City of Springfield.*

GENTLEMEN: — The State Board of Health has considered your request for an examination of Chapin, Loon and Five Mile ponds, and advice as to their fitness for use as sources of drinking water supply during the period when the use of the water of Ludlow Reservoir is inadvisable, and has caused the ponds and their surroundings to be examined by its engineer.

Attention has been called to the possibility of pollution of Five Mile Pond by matters falling from the cars of the Boston & Albany Railroad, and to the possible pollution of Loon Pond by a drain which receives surface and subsoil water from beneath the bridge of the Boston & Albany Railroad and discharges into the upper end of that pond.

It is suggested that any water which might flow into Five Mile Pond through the gutter along the southerly side of the railroad track east of the pond can be diverted without special difficulty into the northerly part of the pond, whence it could reach the intake of the Springfield water works only by filtering through the ground or the gravelly embankment of the railroad. It is also suggested that the embankment of the railroad might be raised along its southerly side where it passes through the pond, and such water as may flow off the roadbed be diverted to porous land on the westerly side of the pond, whence it could enter the pond only after filtration for a long distance through the ground.

In the opinion of the Board, these changes would dispose of any possible danger that may exist of the serious pollution of the water of Five Mile Pond by matters falling from the railroad cars.

The water of the drain entering Loon Pond does not show evidence of pollution, but it appears possible to discharge it upon a filter bed formed of porous material in the neighborhood of its outlet; and if this should be done, any possible danger of the serious pollution of the water of Loon Pond by this drain would be prevented. Pollution of the waters of the ponds by the employees at the pumping stations can easily be prevented, and pollution by visitors can be prevented by maintaining efficient inspection of the shores, as the Board is informed is being done at present.

DEC. 6, 1906.

*To the Board of Water Commissioners of the City of Springfield.*

GENTLEMEN: — The State Board of Health has considered your application for the approval of certain plans for taking an additional water

supply from the Westfield Little River, and has caused the locality to be examined by its engineer.

The plans provide for diverting the water of the Little River at a point in the gorge, so called, where the elevation of the bottom of the river appears to be more than 400 feet above sea level, and conveying it through a tunnel to filters to be located above the village of West Parish, thence through a 38-inch steel pipe to a distributing reservoir to be located on Proven Mountain and to have a present capacity of at least 15,000,000 gallons, from which it will flow to the city through a pipe 42 inches in diameter, delivering the water into the present pipe system.

The plans show locations for two storage reservoirs within the Little River water-shed: one on the main stream, to be known as the Cobble Mountain Reservoir, and another on Borden Brook, to be known as the Borden Brook Reservoir.

The plan in general is designed to develop in the beginning a supply of about 15,000,000 gallons from the Little River water-shed; and it is probable that reservoirs can be constructed within the water-shed at either of the locations suggested, of sufficient size to secure that quantity of water at all times. The pipe line from the filters to the Proven Mountain Reservoir, as shown on the plan, is sufficient to carry somewhat more than 15,000,000 gallons per day; and the capacity of the pipe line from the reservoir to the city is larger.

The Board, having considered the plans presented, approves the location of the proposed reservoirs, the location of the proposed filters and the plans presented for conveying water from below the proposed filters to the city of Springfield. The plans of the works for storing and filtering the water are not included in these plans.

The plans presented as above are two in number, and bear the following titles: "Sheet No. 1. Springfield Water Works. Little River Supply. General Plan showing Proposed Source and Manner of Utilizing it. October 5, 1906." "Sheet No. 2. Springfield Water Works. Little River Supply. Cobble Mountain Reservoir to Petersons, showing General Location of Proposed Structures. October 5, 1906."

## Springfield (Kibbe Brothers Company).

July 5, 1906.

*To the Kibbe Brothers Company, Springfield, Mass.*

Gentlemen: — In response to your request for an examination of a driven well used as a source of water supply in your factory in Springfield, the Board has caused the well and its surroundings to be examined and samples of the water to be analyzed.

The results of the analyses do not show that the water is being seriously polluted at the present time, but it is excessively hard; and, in

view of the fact that the well is located in the densely built-up portion of the city where the ground water is exposed to pollution, the Board would recommend that its further use for drinking be discontinued.

### Stoughton (Wells).

Nov. 1, 1906.

*To the Board of Health of the Town of Stoughton.*

Gentlemen: — In response to your request of Oct. 11, 1906, for an examination of the water of certain wells in Stoughton and advice as to its quality, the Board has caused three wells indicated by you — one located at Upham's Corner, at the intersection of Lincoln and Pleasant streets, a second near the standpipe, and a third on the property of the Stoughton Rubber Company — to be examined by one of its engineers and samples of their waters to be analyzed.

The waters of all of these wells show decided evidence of serious pollution by sewage, and, in the opinion of the Board, cannot be regarded as safe for drinking.

### Swampscott (Moose Hill Spring).

Oct. 4, 1906.

*To the Board of Health of the Town of Swampscott.*

Gentlemen: — The State Board of Health, in accordance with a request from the board of health of the city of Lynn, has caused an examination to be made of Moose Hill Spring and its surroundings in Swampscott and a sample of the water to be analyzed.

The results of the examination show that the spring is located in a thickly populated district, and the analysis shows that it is highly polluted. The Board would recommend that measures be taken to prevent the further use of the water of this spring for drinking.

### Swampscott (E. B. Greenleaf).

Dec. 6, 1906.

*To Mr. E. B. Greenleaf, 168 Chestnut Street, Lynn, Mass.*

Dear Sir: — In response to your request of Nov. 23, 1906, for an examination of the water of a spring in Swampscott from which you propose to take water to sell to the public for drinking, and advice as to its quality, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water entering the spring has been polluted and not thoroughly purified in its subsequent passage through the ground.

The Board cannot recommend the use of this water for drinking, but will make a further examination of the source next spring, if you so request, to determine whether any change has then taken place in the quality of the water.

### Taunton.

The rules and regulations adopted by the Board in June, 1902, for the sanitary protection of the water supply of Taunton, were amended by the Board on July 5, 1906, so as to provide for the regulation of boating, fishing, ice cutting, etc., thereafter by the State Board of Health, instead of the local water board.

### Wakefield.

Dec. 6, 1906.

To Mr. George H. Maddock, *Chairman of Committee on Purchase of Land for the Protection of the Water Supply of Wakefield.*

Dear Sir: — In accordance with the request of your committee for advice as to the advisability of the town of Wakefield purchasing certain lands along the westerly side of Crystal Lake, extending southerly from the neighborhood of the pumping station, for the purpose of preventing the pollution of the water supply, the Board has caused the locality to be examined by one of its engineers and has considered the plan presented and the necessity or desirability of the town controlling the land in question.

The area which it is proposed to take extends along the lake shore for a distance of about a quarter of a mile, and extends back from the shore a maximum distance of between 500 and 600 feet. All of the land is within the water-shed of the lake and most of it slopes quite steeply down to its shore. There can be no question as to the danger of direct pollution of the lake if buildings should be constructed on these lands, and this pollution would enter the portion of the lake adjacent to the pumping station. In the opinion of the Board, it is necessary for the town to control the lands along this shore of the lake in order to adequately protect the purity of the water, and the Board would recommend the town to secure and retain control of the whole area here indicated during the time that the lake is used as a source of water supply.

### Waltham (Judson L. Thomson Manufacturing Company).

March 1, 1906.

*To the Judson L. Thomson Manufacturing Company, Waltham, Mass.*

Gentlemen: — In response to your request for an examination of the water of a well at your factory from which you wish to supply water to the operatives for drinking, the Board has caused the well and its surroundings to be examined by one of its engineers and samples of its water to be analyzed.

The results of the analyses show that the water is excessively hard

and contains a larger quantity of organic matter and bacteria than are found in good well waters, and, in the opinion of the Board, is unsafe for drinking.

### Wayland.

Sept. 6, 1906.

*To the Board of Water Commissioners of the Town of Wayland.*

Gentlemen: — Complaint having been made to the State Board of Health that the quality of the water supplied from the works of the village of Cochituate is very objectionable on account of a disagreeable taste and odor, the Board has caused the sources of supply to be examined and has considered the results of numerous analyses of samples of this water.

It appears that water can be taken either directly from the reservoir or from a filter-gallery near the reservoir. The water of the reservoir itself is highly colored and contains a large amount of organic matter, and the results of this and previous examinations show that it is often objectionable for drinking on account of the disagreeable taste and odor.

The filter-gallery is located close to the shore of the reservoir, and the water which enters it comes principally from the reservoir by filtration through the ground. The purification of the water in its passage through the ground is not thorough, and it is affected, usually, by the presence of an excessive quantity of iron, which renders it very objectionable for many domestic purposes.

As you have already been advised in a previous communication from this Board, the water in the filter-gallery cannot be improved by any changes that it is practicable to make either in the reservoir or in the filter-gallery itself. The water of the reservoir might be improved by a thorough cleaning of the bottom and the removal of all mud and other organic matter therefrom, and by the drainage of swamps on the water-shed; but the cost of thoroughly cleaning this reservoir would be considerable, and it would probably be impracticable to do this work unless a supply for the town should be secured, temporarily, at least, from some other source.

It would probably be better for the town to abandon the present reservoir and filter-gallery and secure a supply from a new source, and the Board would advise that investigations be begun with a view to obtaining a supply of water of good quality from some other source than the one now used.

### Wellesley (Wellesley College).

Oct. 4, 1906.

To Miss Ellen F. Pendleton, *Dean, Wellesley College, Wellesley, Mass.*

Dear Madam: — In accordance with your request of Sept. 26, 1906, the State Board of Health has caused a group of tubular wells on the Wellesley College grounds, used as the source of water supply, to be examined by one of its engineers and samples of the water to be analyzed.

The results of the analyses show that the quality of the water is about the same as it was in December, 1905, and that it is at present of good quality for drinking purposes.

Examinations of this water should be made from time to time, in order that any deterioration may be detected, since there are possible sources of pollution in the region of the wells which may in time affect the quality of the water.

## WESTBOROUGH.

MARCH 21, 1906.

*To the Board of Water Commissioners of the Town of Westborough.*

GENTLEMEN: — The State Board of Health received from you on Feb. 21, 1906, an application for advice as to certain proposed changes in the system of filtration and storage of water for the supply of the town of Westborough, accompanied by plans and a report by your engineer showing the character of the proposed works.

It appears that at the present time the water supply of the town is obtained from the lower basin of Sandra Pond, into which enough water filters from the upper basin through the gravelly soil between them to furnish all of the water now used by the town, the high-water level of the upper basin being about 8 feet above that of the lower basin. The water of the upper basin, which is shallow, contains at times an excessive quantity of organic matter, but it is well purified in its passage through the ground before entering the lower basin. The water of the latter source, however, is exposed to light and is affected at times by growths of organisms which give the water a disagreeable taste and odor.

The plan now presented provides for the construction of filter-galleries between the upper and lower reservoirs, to collect the water which now filters into the lower reservoir; and, in connection with this plan, it is proposed to raise the upper reservoir about 1 foot.

The filter-galleries, as shown upon the plan, are to be constructed in nine sections, each 5 feet in width and 7 feet in height, with their bottoms 8 feet below the level of the lower reservoir, so arranged that each one of them can be separated from the others if necessary and its use discontinued by closing a gate. The total capacity of these galleries is 100,000 gallons, which is expected to be sufficient to provide for fluctuations in the draft of water through the day.

Several test wells have been driven in the area between the reservoirs, to obtain information as to the character of the soil, and samples of water from some of the wells have been analyzed.

The Board has caused the locality to be examined by its engineer and has considered the plan presented.

The soil in the area between the upper and lower reservoirs, as shown

by the test wells, is coarse and porous; and the ground water in this area, so far as could be judged from the samples examined, is of good quality. It is impracticable to determine beforehand how large a proportion of the water filtering out of the upper reservoir will be collected by the proposed new filter-galleries, but it seems probable that the quantity will be approximately the same as that which is now collected in the lower basin. In any case, it would doubtless be practicable, by extending the galleries, to intercept all of the ground water which now enters the lower basin.

The yield of the lower basin in former years appears not to have been sufficient for the requirements of the town at all times, but since certain measures were taken to restrict waste and to meter the water supplied to consumers, the lower basin has furnished all of the water required; and it is probable that, with the added storage in the upper reservoir that will be obtained by raising its level as proposed, a sufficient supply for the town, including the insane hospital, can be obtained from these sources. Additional filter-galleries can be built if necessary; and it appears to be practicable, if the supply should prove inadequate, to divert into the upper basin the waters of a stream flowing in an adjacent water-shed west of your present source, and thus increase materially the quantity of water available.

Considering the circumstances, the Board is of the opinion that the plan presented is a practicable and satisfactory method of obtaining a supply of good water for the town of Westborough, including the Westborough Insane Hospital, if the latter institution should be supplied in future from the water works of the town.

The Board would advise that the town provide a meter or some other suitable means of measuring all of the water used, and that records be kept both of the quantity of water used and of the height of water in the reservoirs and filter-galleries, in order that unnecessary use or waste of water may be detected and restricted and the sources enlarged when the records indicate that an enlargement has become necessary.

### WESTBOROUGH (INSANE HOSPITAL).

AUG. 2, 1906.

*To the Board of Trustees of the Westborough Insane Hospital,* GEORGE S. ADAMS, M.D., *Superintendent.*

GENTLEMEN: — The State Board of Health received from you on July 12, 1906, an application requesting its advice as to a proposed water supply for the Westborough Insane Hospital, accompanied by plans which provide for taking the water from the open channel of the Wachusett Aqueduct at a point about 750 feet below the lower end of

the covered channel and conveying it through a 12-inch pipe about a mile in length to a pumping station, from which the water is to be pumped a further distance of about 3,600 feet to the present water tower, whence it is to be distributed to the hospital buildings.

The Board has caused the locality from which it is proposed to take the supply to be examined by its engineer, and has considered the plans presented. The Wachusett Aqueduct conveys water from the Wachusett Reservoir to the Sudbury Reservoir, and under all ordinary conditions the hospital would obtain under the proposed plan an ample supply of water, the quality of which would be practically the same as that of the Wachusett Reservoir. It is necessary at times, however, to shut off the flow of water through the aqueduct, especially for the purpose of cleaning it, and at such times the quality of the water obtainable at the point at which it is now proposed to take it for the supply of the hospital would be likely to be very different from its ordinary character. Water used in cleaning the upper portions of the aqueduct may be discharged through waste gates at various points; but the water used in cleaning the lower section, about a mile in length, must be discharged into the open channel and must pass the point from which the supply of the hospital would be drawn, and at such times the quality of the water would be objectionable. Moreover, the outlet of the main drainage system of a large swamp discharges into the aqueduct a short distance below the intake, and when the flow into the aqueduct is cut off the water obtainable by the hospital might come largely from this swamp.

In order to provide a supply of water for the institution at times when water cannot be obtained from the aqueduct, or when the water from that source may be objectionable for any reason, it is proposed to maintain the present works for taking water from a system of driven wells near the northerly end of Chauncy Pond. The water of these wells contains an excessive quantity of iron, which makes it disagreeable for drinking and objectionable for many other purposes; and it is to avoid the use of this water, or of water taken directly from Chauncy Pond, the quality of which is also unsatisfactory, that the new works are to be constructed.

While the results of investigations made some time ago with a view to obtaining a supply of water for the hospital from the ground in the neighborhood of Chauncy Pond were not favorable, these investigations do not appear to have been sufficiently thorough to show definitely whether or not it is practicable to obtain a satisfactory water supply for the institution in that way.

If a good ground-water supply could be obtained in this region, it would not only be superior in quality to that obtainable from the aque-

duct, but the cost of supplying water to the institution in that way would doubtless be much less; and, with its present information, the Board is unable to advise that the source of supply now proposed is the most appropriate one for the use of the Westborough Insane Hospital.

The aqueduct water is of good quality, however, under all ordinary circumstances; and if provision shall be made for obtaining a supply of good water for use at times when water cannot be obtained from the aqueduct, or when its quality is unsatisfactory, there would be no objection, from a sanitary point of view, in the opinion of the Board, to taking a supply from the aqueduct by the plan now proposed.

SEPT. 6, 1906.

*To the State Board of Insanity,* OWEN COPP, M.D., *Executive Officer.*

GENTLEMEN: — The State Board of Health received from you on Aug. 18, 1906, a communication requesting advice as to a modified plan for supplying Westborough Insane Hospital with water from the aqueduct of the metropolitan water works, which provides for taking an auxiliary supply from the works of the town of Westborough for use at such times as it may be necessary or desirable to shut off the aqueduct supply; and it is further stated that the water commissioners are willing to furnish water to the hospital at such times.

The Board has considered the plan presented, and is of the opinion that a supply of good water for the Westborough Insane Hospital can be obtained under the plan presented, provided the works for supplying water from the water-supply system of the town of Westborough, the size and capacity of which are not indicated, are made adequate for the requirements of the hospital whenever the supply from the aqueduct may be shut off.

## WEST BRIDGEWATER (HOWARD SEMINARY).

AUG. 2, 1906.

To Mr. ANDREW J. BAILEY, *of the Board of Trustees of Howard Seminary.*

DEAR SIR: — In response to your request of July 18, 1906, for an examination of the water of a well located on the grounds of the Howard Seminary in West Bridgewater, from which the supply of drinking water for the seminary is taken, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water contains iron in such quantity as to make it turbid and give it a noticeable color; but it is evidently unaffected by sewage pollution, and, in the opinion of the Board, is safe for drinking. Waters affected by an excess of iron are objectionable for domestic use, and it is desirable that a water of better quality be obtained for the use of the seminary when practicable.

## Westford.

March 8, 1906.

*To the Board of Selectmen and the Water Supply Committee of the Town of Westford.*

Gentlemen: — The State Board of Health has considered your application for advice with reference to a proposed water supply for the town of Westford, to be taken from the ground near the edge of a meadow west of the Nashua, Acton & Boston Railroad and north of the road leading from Forge Village to Westford Centre, and has caused samples of water from test wells in this locality to be analyzed.

The results of the analyses show that the water of these wells is of good quality for all the purposes of a public water supply.

The tests do not show definitely the character of the soil in which the wells were driven, but water could be pumped from them freely with a hand pump, and the soil appears to be favorable, judging from surface indications, for yielding water freely to wells or other suitable collecting works in this region. The tests are too limited, however, to enable the Board to advise you definitely that a sufficient quantity of water of good quality for the supply of Westford can be obtained from the ground in this region; and the Board would advise that, before finally deciding upon the location of works for obtaining a water supply for the town, you drive a number of additional wells in this region and connect them together, and pump from them for a period of several days at a rate such as will be necessary for the supply of the town.

If you decide to make such a test, the Board will, upon application, analyze samples of the water from time to time during the progress of the test, and will then advise you as to whether the source is a suitable one for the supply of Westford. The Board would again advise that in further investigations you secure the assistance of an engineer of experience in matters relating to water supply.

## Weston (Weston Athletic Association).

Sept. 6, 1906.

Mr. Edward B. Field, *President, Weston Athletic Association, Weston, Mass.*

Dear Sir: — In response to your request for an examination of the water of the Weston swimming pool and the filter used in connection therewith, and advice as to a remedy for the objectionable turbidity and color of the water, the Board has caused the locality to be examined and samples of the water to be analyzed.

It appears from this examination that the swimming pool holds about 42,000 gallons of water, and is situated in an enclosure surrounded by a fence, but open freely to the sunlight, and that it is the intention

to purify the water in the pool about twice a week. The water used is supplied from the works of the Weston Aqueduct Company, which derives its water from tubular wells, and the water supplied to the swimming pool is clear and nearly colorless and contains but little organic matter. After standing in the pool, however, the water acquires the turbidity and greenish color complained of; and the examination shows that this is caused by the presence of enormous numbers of a certain microscopic organism, one of the kinds which are known to grow in great abundance in ground waters when exposed to the light.

The filter now used for the purification of the water of the tank has an area of 180 square feet, and is entirely inadequate properly to purify the water of the tank. The present method of drawing water out at one end of the pool, passing it through the filter and delivering it back at the other end, results in filtering only a portion of the water, and the filtered water under present conditions doubtless assists in maintaining the growth of organisms in the tank. Moreover, this filter is not of sufficient capacity to make it practicable to filter the water properly before discharging it into the adjacent stream, which is a tributary of the Cambridge water supply.

In response to a previous communication relative to the construction of this swimming pool, the Board, on Aug. 3, 1905, advised you that in order to obtain satisfactory results in the purification of the water of the swimming pool the filter should have an area of at least 2,000 square feet and a depth of 5 feet of filtering material, and that the water should not be applied at a greater rate at any time than 3,000,000 gallons per acre per twenty-four hours. A copy of this communication is enclosed herewith.

The Board would recommend that you install a filter of at least the area already advised; and if, in connection with this filter, you should provide a tank of sufficient capacity so that the swimming pool can be completely emptied each time it is drawn off, and all of the water filtered before being returned to the pool, it is probable that the objectionable conditions caused by the growths of organisms will be less noticeable than at the present time. Such a filter, operated at a rate no greater than 3,000,000 gallons per acre per day, is necessary in any case in order to purify the water when it is discharged into the neighboring water course. The auxiliary tank need not be as large as the capacity of the pool, since much of the water and probably the greater portion can be drawn directly upon the filter, provided the outlet is suitably controlled.

Even with such a filter, it is questionable whether the growths of organisms will not still be objectionable. Such growths can probably be

prevented by covering the swimming pool and excluding the light, but it will probably be more satisfactory to renew the water frequently and wash out the tank at each change of water.

### Weston (F. H. Hastings).

Oct. 4, 1906.

To Mr. F. H. Hastings, *Weston, Mass.*

Dear Sir: — In response to your request of September 13 for an examination of the water of a well in Weston from which you propose to take water for the supply of certain dwelling houses near Kendal Green, the Board has caused the well and its surroundings to be examined and samples of the water to be analyzed.

At the time these examinations were made the water was turbid and colored and contained a much larger quantity of organic matter than is found in good well waters. The results of the analyses indicate that the water entering the well has at some time been polluted, but under the existing conditions there appears to be no practicable way of determining definitely the probable quality of the water until the well has been completed and a considerable quantity of water drawn from it. While it is probable, judging from the results of the recent analyses, that the water entering the well is affected by the sewage deposited upon or in the ground at the dwelling houses near by, it is possible that the water will be so thoroughly purified in its passage through the ground that it may safely be used for drinking.

If you decide to complete the well, the Board will make a further examination of it if you so request.

### West Springfield.

March 8, 1906.

*To the Board of Water Commissioners of the Town of West Springfield.*

Gentlemen: — The State Board of Health received from you on Feb. 10, 1906, an application requesting the approval by the Board, under the provisions of section 3 of chapter 333 of the Acts of the year 1905, of the taking, for the protection of the purity of certain proposed sources of water supply, of certain lands located on both sides of Bear Hole Brook in the town of West Springfield, and extending about 4,800 feet down stream from Massasoit Spring, so called, and up stream to the vicinity of Bradley Street, about 3,400 feet above said spring, the area to be taken being described in the application and shown upon plans submitted therewith.

Acting under the authority of the statute above referred to, the State Board of Health gave a public hearing at its office, room 143, State House, Boston, on Thursday, March 1, 1906, at 11.30 o'clock, notice of

the hearing having been given by publication in three newspapers circulating in West Springfield. At this hearing no person appeared to object to the taking of the lands described.

The Board, having considered the proposed plans, hereby approves the taking of the lands shown upon a plan entitled: "Town of West Springfield. Plan of Proposed Land Taking to Protect Purity of Bear Hole Supply. Scale 1 inch = 300 Feet. February 6, 1906. F. A. Barbour, Consulting Engineer, Boston, Mass."; said lands being bounded, measured and described as follows: —

A certain parcel lying on the westerly side of Great Plains Road, so called, in the Town of West Springfield, owned by Belle C. Tourtelotte *et al.*, bounded and described as follows: beginning at a point on the westerly side of Great Plains Road, so called, at its intersection with the division line between "Mountview Park" and the property herein described, thence N. 77° 17′ W. a distance of 639.55 feet to land of Dexter E. Tilley; thence N. 32° 33′ W., a distance of 303.45 feet by land of said Tilley; thence N. 66° 23′ W., a distance of 363.37 feet to an old pipe; thence S. 25° 01′ W., a distance of 396.15 feet to an old pipe; thence S. 24° 40′ W., a distance of 189.65 feet to an old pipe; thence S. 48° 07′ E., a distance of 241.56 feet; thence S. 48° 52′ W., a distance of 287.36 feet; thence S. 77° 47′ 30″ W., a distance of 37.50 feet; thence S. 50° 28′ W., a distance of 77.38 feet; thence S. 31° 43′ W., a distance of 361.77 feet; thence S. 14° 12′ 30″ W., a distance of 87.66 feet; thence S. 28° 29′ W., a distance of 174.30 feet; thence S. 2° 58′ W., a distance of 193.40 feet; thence S. 27° 46′ E., a distance of 76.18 feet; thence S. 4° 18′ W., a distance of 258.42 feet; thence S. 12° 56′ W., a distance of 225.55 feet; thence S. 23° 52′ W., a distance of 190.39 feet; thence S. 4° 03′ W., a distance of 60.80 feet; thence S. 29° 18′ W., a distance of 96.32 feet, to a point on the southerly line of Bagg Pasture, so called, which is a part of the parcel of land herein described; thence N. 51° 31′ W., a distance of 1088.56 feet, along the southerly line of said Bagg Pasture; thence N. 53° 45′ 30″ W., a distance of 265.16 feet; thence N. 51° 44′ W., a distance of 145.27 feet; thence N. 48° 27′ W., a distance of 176.18 feet; thence N. 42° 37′ E., a distance of 118.42 feet; thence N. 30° 50′ E., a distance of 110.30 feet; thence N. 42° 04′ E., a distance of 137.73 feet; thence N. 26° 34′ E., a distance of 231.54 feet; thence N. 41° 32′ E., a distance of 119.47 feet; thence S. 65° 48′ E., a distance of 143.55 feet; thence S. 63° 18′ E., a distance of 94.53 feet; thence S. 63° 28′ 30″ E., a distance of 81.33 feet; thence in same course 101.38 feet; thence northerly along to easterly line of land owned now or formerly by Richard Bagg N. 27° 25′ 30″ E., a distance of 1124.30 feet to a point on the northerly line of property now or formerly owned by Richard Bagg; thence N. 51° 12′ 30″ W., a distance of 469.54 feet along said northerly line to a point in the division line between property of said Bagg and Betsey Dewey; thence N. 51° 34′ 30″ W., a distance of 143.98 feet along northerly line of land of said Betsey Dewey to a pile of stones; thence N.

38° 25′ 30″ E., along easterly line of said Dewey, a distance of 125.36 feet to a stake and stones; thence N. 50° 21′ 30″ W., a distance of 1139.60 feet along northerly line of said Dewey to a point on the town line between the towns of Westfield and West Springfield; thence N. 32° 12′ E., along said line a distance of 1605.27 feet to an angle in said town line; thence S. 47° 41′ E., a distance of 899.40 feet, along the southerly line of land leased to the New England Trap Rock Co.; thence N. 43° 01′ E., a distance of 1089.0 feet along easterly line of land leased to said New England Trap Rock Co.; thence N. 25° 36′ 30″ E., a distance of 1243.74 feet along easterly line of said leased land; thence N. 46° 56′ W., a distance of 1426.55 feet to a point on the easterly location line of the N. Y., N. H. & H. R.R.; thence N. 43° 38′ E., a distance of about 235 feet along easterly location line of said railroad to a point in the highway known as Bush Notch Road or Prospect Ave.; thence N. 71° 11′ E., along said highway 248.38 feet; thence N. 61° 41′ E., a distance of 414.07 feet along said highway to a stake and stones marking a point in the division line between the parcel of land herein described and land now or formerly of Albert Tatro; thence S. 47° 32′ E., along southwesterly line of said Tatro, a distance of 677.05 feet; thence N. 38° 44′ 30″ E., a distance of 181.10 feet along southerly line of said Tatro; thence N. 55° 50′ 30″ E., a distance of 219.60 feet along said line of said Tatro; thence N. 44° 44′ 30″ E., along line of said Tatro a distance of 92.61 feet; thence N. 14° 43′ E., along easterly line of said Tatro, a distance of 166.15 feet; thence N. 46° 42′ 30″ E., a distance of 213.48 feet, along line of said Tatro; thence N. 38° 56′ E., a distance of 115.75 feet, along southeasterly line of said Tatro; thence N. 44° 49′ E., a distance of 190.37 feet to a point in the division line of said Tatro and land now or formerly of H. H. Hubbard; thence S. 49° 25′ E., a distance of 530.60 feet, along southwesterly line of said Hubbard to a point in the division line of said Hubbard, and land now or formerly of Kane; thence S. 21° 40′ 30″ W., a distance of 641.52 feet along the northwesterly line of said Kane; thence S. 22° 49′ W., a distance of 213.49 feet along the northwesterly line of said Kane; thence S. 22° 56′ W., a distance of 168.75 feet along the northwesterly line of said Kane to a point in the division line of said Kane and Louis White; thence S. 32° 09′ W., a distance of 239.60 feet, along the northwesterly line of said White to an old pipe; thence S. 33° 05′ W., a distance of 256.65 feet, along the northwesterly line of land of said White; thence S. 40° 05′ W., a distance of 78.82 feet along the northwesterly line of said White; thence S. 9° 20′ 30″ W., a distance of 129.30 feet, along the westerly line of land of said White; thence S. 42° 22′ 30″ W., a distance of 125.77 feet, along the northwesterly line of land of said White; thence S. 31° 0′ 30″ W., a distance of 144.37 feet, along the northwesterly line of land of said White; thence S. 23° 13′ 30″ W., a distance of 243.66 feet along land of said White; thence S. 14° 07′ 30″ W., a distance of 112.33 feet along land of said White; thence S. 28° 26′ 30″ W., a distance of 146.74 feet, along land of said White; thence S. 76° 47′ E., a distance of 1192.10 feet, along the southwesterly line of land of said White to a point on the highway known as Great Plains Road; thence S. 24° 02′ W., a distance of

1819.64 feet along said highway; thence S. 16° 11′ W., a distance of 1015.46 feet along said highway; thence S. 4° 01′ W., a distance of 698.59 feet, along line of said highway to point of beginning.

## WINCHENDON.

MARCH 1, 1906.

*To the Board of Water Commissioners of the Town of Winchendon*, Mr. WALDO C. CORBY, *Secretary.*

GENTLEMEN: — The State Board of Health has considered your communication of Feb. 13, 1906, requesting its opinion as to whether the pumping of river water into the town system of water pipes in case of a great emergency would injure permanently the quality of the water or make it objectionable in any way, and has caused the proposed source of supply to be examined by one of its engineers.

It appears that under the proposed plan water might be pumped into the water supply pipes of the town of Winchendon at three points: one at Winchendon Springs, another near the center of the village and a third at the lower end of the village.

The results of an examination of the water-shed of Millers River show that the stream is polluted to such an extent that its water is unsafe for drinking; and, in the opinion of the Board, there would be danger that this water, if introduced into the water supply pipes of the town, would cause disease. The effect of the introduction of such water, even for a very short time, into the water pipes could not be easily removed; and the Board would advise that no connections be permitted through which water from the river may enter the water supply pipes of the town.

## WOBURN (A. EDWARD ROYS).

DEC. 6, 1906.

To Mr. A. EDWARD ROYS, *65 Brighton Avenue, Allston, Mass.*

DEAR SIR: — The State Board of Health received from you on Nov. 6, 1906, a communication stating that you are intending to take water from a spring located in the valley of Willow Brook not far from Merrimac Street in North Woburn to sell for drinking, and requesting advice as to its quality; and in response to this request the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The water of the spring is apparently naturally of good quality, though it contained at this time a slightly larger quantity of organic matter than is found in good ground waters, and a considerable quantity of iron. There are no sources of pollution in the neighborhood of the spring, and it is probable that, if it were walled up and protected from the entrance of surface water and from the light, water of good quality for drinking could be obtained from it.

## Ice Supplies.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sources of ice supply: —

### Framingham.

April 5, 1906.

*To the Board of Health of the Town of Framingham,* Mr. Charles N. Hargraves, *Chairman.*

Gentlemen: — In response to your request of March 24, 1906, for an examination of ice cut from Bannister Pond in the town of Framingham and advice as to its quality, the Board has caused the pond to be examined and samples of the water and ice therefrom to be analyzed.

The water of Bannister Pond is derived chiefly at the present time from Bannister Brook, which receives the effluent from the Framingham and Natick sewage-disposal areas, and is at times polluted by crude sewage from the Natick works.

The results of the analyses show that the water is highly polluted, and that the ice contains a much greater quantity of organic matter than is found in good ice, and an excessive number of bacteria, including those characteristic of sewage.

The Board would advise that the use of this ice in contact with food or drinking water be prevented.

### Medford.

April 5, 1906.

*To the Board of Health of the City of Medford.*

Gentlemen: — In accordance with your request of Feb. 27, 1906, for an examination of the ice taken from clay pits located at the foot of Buzzels Lane near Mystic Park, and advice as to its quality, the Board has caused the locality to be examined and a sample of the ice to be analyzed.

The results of the examination show that the water entering the clay pit from which the ice is taken is polluted by the discharge of sewage either directly into the pit itself or into its tributaries, and the results of the analysis show that the ice contains a higher quantity of organic matter and a larger number of bacteria than are found in good ice.

In the opinion of the Board, this clay pit is not a suitable source of ice supply, and ice cut therefrom should not be used where it may come in contact with food or drinking water.

## NORTHAMPTON.

OCT. 4, 1906.

*To the Board of Health of the City of Northampton.*

GENTLEMEN: — The attention of the State Board of Health having been called by the Inspector of Provisions to certain sources of ice supply in the city of Northampton from which ice is taken for use for domestic purposes in the city, the Board has caused the sources of supply to be examined and samples of the water and ice, where available, to be analyzed.

The sources indicated are Rocky Hill Pond, so called, about a mile southwest of the Northampton Insane Asylum, a pond on the northerly side of the Easthampton road, about a mile and a half from city hall, and a pond on the southwesterly side of the road leading from Bay State to Leeds, south of Mill River.

The water of two of the sources, while containing considerable organic matter, does not appear to be exposed to danger of serious pollution. No water was obtainable from the third source, — the pond near Leeds, — which has a very small water-shed, and it is understood that water from the city mains is used in dry seasons to supply the pond.

Samples of ice harvested from the pond near the Easthampton road and from the pond near Leeds were obtained for analysis. Both contained a layer of snow ice at the surface, but the clear ice was of good quality.

In the opinion of the Board, it is practicable under present conditions to obtain from each of these sources ice of good quality for domestic purposes by removing from the ice the first inch of clear ice that formed upon the pond and all ice formed above it by snow, rain or flooding, and retaining for use only the clear ice formed beneath the first inch. It is also important to avoid the use of ice containing particles of foreign matter.

## SOUTH HADLEY.

JUNE 7, 1906.

To Mr. M. L. WELCKER, *Selectman, South Hadley, Mass.*

DEAR SIR: — In response to your request for an examination of a quantity of ice cut during the past winter from a pond on Muddy Brook, so called, and advice as to its quality, the Board has caused the source from which the ice was taken to be examined by one of its engineers and a sample of the ice to be analyzed.

The pond from which the ice is taken is of considerable depth and extent, but it does not appear to be exposed to pollution to such an extent as would make it an unsafe source of ice supply.

The sample of ice examined contained a larger quantity of organic

matter than is found in good ice, but the number of bacteria was low, and the sample appeared to be free from foreign matter.

Considering the circumstances, in the opinion of the Board the ice may safely be used for domestic purposes.

## West Newbury.

Aug. 2, 1906.

To Mr. E. N. Chase, *Town Clerk, West Newbury, Mass.*

Dear Sir: — In response to your request for advice as to a proposed ice supply to be taken from a reservoir on a small water course near the southwesterly end of the village of West Newbury, south of the road leading from West Newbury to Groveland, the Board has caused the locality to be examined by one of its engineers and has considered the information presented.

It appears that it is proposed to construct in the locality indicated a reservoir having an area of about an acre and a depth of about 3 feet, from which to take ice to be sold to the public for domestic purposes.

It has not been practicable to obtain a sample of the water with which the proposed ice pond will be filled; but the area from which the water is to be derived is free from buildings, and, if the reservoir shall be made of a depth of at least 3 feet and the area flowed kept free from weeds and tall grasses, ice of good quality for domestic purposes can, in the opinion of the Board, be obtained therefrom.

## Winchendon (Baxter D. Whitney and Son).

Dec. 6, 1906.

To Baxter D. Whitney & Son, *Winchendon, Mass.*

Gentlemen: — In response to your request of Nov. 12, 1906, for an examination of the water and ice from your mill pond and advice as to its quality, the Board has caused the source of supply to be examined and a sample of ice found in one of the ice houses on the shore of the pond to be analyzed.

This ice was formed partly of clear ice and partly of snow ice, and, though containing considerable organic matter, the number of bacteria was small.

The mill pond is large and quite deep, but it receives considerable pollution from mills on the stream which enters it. In order to obtain ice from this pond which may safely be used for domestic purposes, it will be necessary to remove from the ice, when harvesting, the first inch that formed upon the pond, including all snow ice and ice formed by flooding, and retain for use only the clear ice forming beneath the first inch. It is also important that all ice containing particles of foreign matter be rejected.

## Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sewerage and sewage disposal: —

### Abington (Lewis A. Crossett Company).

Aug. 2, 1906.

To the Lewis A. Crossett Company, *North Abington, Mass.*

Gentlemen: — The State Board of Health received from you on July 5, 1906, an application for advice as to a proposed system of sewage disposal for your factory, accompanied by plans by your engineer showing the location of the proposed sewer and disposal works.

These plans provide for conveying the sewage through a sewer 8 inches in diameter to be laid in Birch and Charles streets to an area of land situated south of the Rockland Branch of the New York, New Haven & Hartford Railroad at the boundary line between Abington and Rockland, where it is proposed to purify it by intermittent filtration and to discharge the effluent into a small stream tributary to French stream, so called.

The Board has caused the locality to be examined by its engineer and has considered the plans presented.

The area of filter beds is somewhat limited but will provide adequately for the disposal of the sewage of the factory if the quantity is no greater than is now anticipated. The filter beds are so located that it is unlikely that odors from them will be noticeable at any dwelling houses in the region, and they can be enlarged, if necessary, without special difficulty or expense. If the beds receive proper care and the sewage is discharged upon them intermittently, the effluent will be well purified and will not cause objectionable conditions in the stream into which it will be discharged.

### Barnstable (State Normal School at Hyannis).

May 8, 1906.

To Mr. William A. Baldwin, *Principal, State Normal School, Hyannis, Mass.*

Dear Sir: — The State Board of Health received from you on March 22, 1906, an application for advice with reference to enlarging the sewage-disposal plant of the State Normal School at Hyannis by the construction of an additional filter bed adjacent to and west of the one now in use, from which it is proposed to dispose of the sewage by applying it in pipes beneath the surface, as in the case of the area now in use.

It appears that the present filter, which has operated satisfactorily for several years, has become clogged, and it is proposed to construct and use the new area, allowing the present area to rest.

In the opinion of the Board, the plan is a satisfactory one for enlarging the sewage-disposal area for the school; and, if the works are carried out in accordance with the suggestions made for the construction of the present filter, the new filter is likely to operate satisfactorily for several years. The present area can probably again be used, as suggested, after allowing it to rest for a time.

## BEVERLY.

MAY 3, 1906.

To Hon. JOSEPH A. WALLIS, *Mayor, Beverly, Mass.*

DEAR SIR:—The State Board of Health received from you on April 25, 1906, the following application for advice as to a proposed outlet for the sewage of a portion of the city of Beverly, accompanied by a plan of the main sewer and outlet:—

The city of Beverly, acting under the authority of section 117 of chapter 75 of the Revised Laws, hereby gives notice of its intention to so modify the system of sewerage heretofore adopted in said city as to provide for dispensing with the outlet at Tucks Point and substituting in place thereof the outlet at the foot of Andrews Court, and herewith submits the proposed plans for your advice as to the best practicable method of disposing of the sewage.

In response to this application, the Board has caused the locality to be examined by one of its engineers and has examined the plan submitted.

The plan now presented provides, as stated in the application, for omitting the construction of an outlet at Tuck's Point and conveying all of the sewage from certain areas in the southerly and westerly portion of Beverly to a main sewer to be laid in Water Street to the shore of the harbor, and thence along the harbor front between high and low water to a connection with the main trunk sewer opposite the foot of Andrews Court, whence the sewage will flow to the present outlet of this sewer, located in the harbor a little less than 700 feet from the shore at high water.

The sewage now discharged at this outlet is quickly dispersed in the water, and the outlet is an unobjectionable one at the present time. The quantity of sewage which would be discharged at this outlet if the sewer now proposed should be constructed would not be very materially increased, judging from the information presented as to the area to be sewered; and, in the opinion of the Board, the plan is an appropriate method of disposing of the sewage of the limited areas that would be tributary to the new sewer in the southerly and westerly parts of the city, and the construction of an outlet at Tuck's Point may reasonably be omitted.

OCT. 30, 1906.

To the Hon. JOSEPH A. WALLIS, *Mayor of the City of Beverly.*

DEAR SIR: — The State Board of Health received from you on Aug. 10, 1906, an application giving notice of a proposed change in the system of sewerage heretofore adopted by the city of Beverly, so as to provide for an additional outlet at a point below the line of low-water mark south of the terminus of Dane Street, and requesting the advice of the Board thereon.

The application is accompanied by a plan indicating the district to be drained and showing the location of the main sewer extending from the foot of Dane Street across the flats in a southwesterly direction to the edge of the main channel about 600 feet beyond low-water mark and 1,600 feet east of the present outlet.

The Board has caused the locality to be examined by its engineer and has considered the plan submitted and the evidence presented at a public hearing given by the Board on October 4.

Much of the more densely populated portion of the city of Beverly is already served by a system of sewers discharging into the harbor through a single outlet off Andrews Court, and observations show that sewage from this outlet discolors the water for a considerable distance about the outlet, and floating matters from the sewage discharged from the sewer can be seen in the water for a much greater distance.

The sewer now proposed is designed to serve a district farther to the east than those served by present sewers, but the outlet pipe would bring the sewage toward the present outlet, where the water is already affected considerably by sewage. It is evident that if the city continues to grow rapidly the discharge of sewage into the harbor in this region is likely to become objectionable within a few years, and some other plan of disposal of the sewage will become necessary.

Under the circumstances, the Board would recommend an investigation to determine the best practicable plan for the future disposal of the sewage of the city of Beverly; and, since it is evident that a considerable saving in the cost of the works may be made by postponing the construction of an additional outlet until the final plan has been determined upon, the Board would not advise the carrying out at present of the plan now proposed.

The Board would recommend that the further investigations as to the future disposal of the sewage of the city be made with the assistance of an expert in matters relating to sewage disposal; and when you have made further investigations and prepared plans the Board will advise you concerning them, and will then advise as to the best plan of providing a temporary outlet for the sewage of the district now under consideration.

### CANTON (MASSACHUSETTS SCHOOL AND HOME FOR CRIPPLED AND DEFORMED CHILDREN).

DEC. 6, 1906.

*To the Board of Trustees of the Massachusetts School and Home for Crippled and Deformed Children, Mr. FRANCIS HURTUBIS, Jr., Secretary and Treasurer.*

GENTLEMEN: — The State Board of Health has considered your application of Nov. 13, 1906, and the plans submitted therewith, providing for the disposal of the sewage at the School and Home for Crippled and Deformed Children, in Canton, and has caused the locality to be examined by its engineer.

It appears that it is proposed for the present to construct an administration building and two school buildings, and it is expected that the number of persons at the institution, in the beginning at least, will be small.

The plan for disposing of the sewage provides for constructing two cesspools in the rear of the buildings on land sloping toward Reservoir Pond, one cesspool to be 10 feet in diameter and 10 feet deep, and the other 8 feet in diameter and 8 feet deep, the sewage to enter the larger cesspool and overflow into the smaller. The proposed sewer is to be laid at such an elevation that in case the cesspools become inadequate for the disposal of the sewage the sewer can be extended farther down the hill and filter beds provided if necessary.

The plan now presented makes reasonable provision under the circumstances, in the opinion of the Board, for the disposal of the sewage of this institution in the beginning. The Board would suggest that the plans be modified so that the sewage shall first enter the smaller cesspool.

### COHASSET.

JULY 5, 1906.

*To the Committee on the Improvement of James Brook, Cohasset, Mass.*

GENTLEMEN: — In response to your request for advice as to the prevention of the pollution of James Brook, the Board has caused the locality to be examined by one of its engineers and finds that at the present time the sewage from twenty or more dwelling houses is discharged directly into the stream, making it very offensive in summer.

The soil in the valley of the brook in the village is fine and nearly impervious to water, and it appears to be impracticable to dispose of the sewage of the houses, from which the brook is now polluted, by means of cesspools.

Under the circumstances, the Board would advise that you employ an engineer of experience in matters relating to sewerage to prepare a plan for disposing of the sewage which now pollutes the brook. It would be

well also, in the opinion of the Board, that the question of the general sewerage of the village be considered at the same time, so that any sewer that may be built for the relief of James Brook may subsequently form a part of a general system.

When you have made a further investigation and prepared a plan for disposing of the sewage the Board will, upon application, give you further advice in this matter.

## CONCORD.

SEPT. 6, 1906.

*To the Board of Water and Sewer Commissioners, Concord, Mass.*

GENTLEMEN: — The State Board of Health has considered your communication of Aug. 1, 1906, relative to the question of the diversion of some of the sewage pumped to the Concord filtration area to certain adjacent lands upon which it is proposed to use it for the purpose of irrigating crops, and has caused the locality to be examined by one of its engineers.

The land in question appears to be well suited for the purification and disposal of the sewage; and, in the opinion of the Board, a portion of the sewage of the town of Concord can be used for the irrigation of crops, as proposed, without causing objectionable conditions in the neighborhood if the sewage is properly applied.

In the use of sewage for the irrigation of crops care must be exercised to avoid spreading contamination therefrom, and special care must be taken to avoid contaminating vegetables or fruits used for food.

## CONCORD (MASSACHUSETTS REFORMATORY).

JULY 5, 1906.

*To the Board of Prison Commissioners,* MR. FREDERICK G. PETTIGROVE, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on June 2, 1906, an application for advice as to a proposed plan of disposing of the sewage of the Concord Reformatory, and subsequently received from your engineer plans and a description of the proposed works.

The plans submitted provide for the construction of 3¾ acres of filter beds, including sludge beds, upon land located between the reformatory buildings and the Assabet River, and for conveying the sewage from the reformatory buildings by gravity to these filter beds, which are provided with underdrains discharging into the river.

It appears that the quantity of sewage at present discharged from the reformatory sewer amounts to about 180,000 gallons per day, and that the sewage is stronger than that disposed of at most of the purification works of the State.

The soil of the proposed filter beds, judging from its character as shown by test pits, is well adapted to the purification of sewage by inter-

mittent filtration, and the area of filter beds is sufficient for present requirements; and the Board is of the opinion that the plans now submitted make adequate provision for the proper purification of all of the sewage now discharged from the institution.

The filter beds are located at a considerable distance from dwelling houses, and, if properly maintained, it is improbable that odors from them will be noticeable at dwelling houses in the vicinity. Special care will be necessary, however, in disposing of the sludge, in order to avoid creating offence in the neighborhood.

By the provisions of section 8 of chapter 151 of the Acts of the year 1895, entitled "An Act to authorize the Town of Concord to construct and maintain a System of Sewerage," the commissioners of prisons are, as you are doubtless aware, directed to connect the sewers and sewerage system of the Massachusetts Reformatory and other property of the Commonwealth in the town of Concord with the main sewer of the said town, whenever such main sewer shall be laid by the town to Concord Junction and connected with the system of sewage disposal established by the town, paying for such privilege in a manner provided in the act.

While it is important that there be no more delay than necessary in providing proper means for purifying the sewage of the reformatory, which now pollutes the Assabet River, — a stream already seriously polluted, — the Board is of the opinion that the possibility of the extension of the Concord sewerage system to the neighborhood of the reformatory within the near future should be ascertained; and, if such extension is likely to be made before the end of next year, it will be best to delay the construction of the proposed works, with a view to connecting with the Concord system. If, however, the extension of the town's system to Concord Junction is not likely to be made in the immediate future, the Board would recommend that you proceed at once with the construction of the works now proposed.

## Foxborough (State Hospital).

Feb. 1, 1906.

*To the Trustees of the Foxborough State Hospital,* Charles E. Woodbury, M.D., *Superintendent.*

Gentlemen: — The State Board of Health received from you on Jan. 2, 1906, the following communication for further advice relative to sewage disposal and water supply at the Foxborough State Hospital: —

Referring to your communications to me of Sept. 7 and Oct. 5, 1905, relating respectively to sewage filtration and water supply, I desire to ask further advice.

First, we are erecting a building for the accommodation of 100 patients, and no further buildings of this character will be erected before 1907, if then.

When the new building is occupied, we may have as many as 325 patients. Four years ago with the old set of buildings I had at one time 306 patients, and the sewage beds discharged their functions satisfactorily. My point is, will it be necessary to increase our area of filtration for this one new building, — the area to be increased as you advise before a second or more new buildings are erected.

Second, you mention probable favorable conditions for water east and west of the hospital.

It is the intention of the trustees to drive wells and erect a water tower, giving us control of our own water supply.

May I ask if you will cause to be indicated suitable places for driving artesian wells?

The Board has considered further the capacity of the present filter beds and the additional requirements of the hospital in the matter of sewage disposal.

In a previous communication the Board advised that a somewhat larger quantity of sewage than that now disposed of on the present sewage-filtration area at this hospital can probably be purified there without overtaxing the filters or creating objectionable conditions. The addition of a new building accommodating 100 patients as now proposed will not apparently increase the number of persons at the hospital materially beyond the numbers which have been present there at times in the past, when the filters were found adequate for the purification of all of the sewage; but the hospital is now to be used for the accommodation of insane patients, and, judging from the experience at other insane hospitals, the quantity of sewage is likely to be larger than under the conditions that have existed hitherto.

It is probable, in the opinion of the Board, that the present filter beds, if properly cared for, will be capable of purifying all of the sewage of the hospital, even after the number of officers and inmates has been increased to 325 by the addition of a new building as proposed; and if the filter beds should become overtaxed, it will not be difficult to enlarge the area within a short time, if necessary.

Regarding the locations for driving wells for the purpose of securing a water supply for the hospital, the Board is unable to give you more definite advice than was contained in its communication of last year. If it is your intention to make further investigations with a view to obtaining an independent water supply, the Board would advise that you secure the assistance of an engineer of experience in the selection of ground-water supplies.

The Board will, if you so request, make the necessary analyses of samples of water from test wells, or other sources that may be proposed, and will give you further advice when you have the results of further investigations to present.

## FRANKLIN.

MARCH 8, 1906.

*To the Board of Selectmen of the Town of Franklin.*

GENTLEMEN: — The State Board of Health received from you on Feb. 1, 1906, an application for advice with reference to a system of sewerage and sewage disposal for a portion of the town of Franklin, accompanied by a plan showing the proposed main sewer and the location of the area upon which it is proposed to purify the sewage. The plan provides for collecting the sewage and manufacturing waste from the portion of the main village in the water-shed of Mine Brook in a system of pipe sewers, through which it is proposed to convey it by gravity to a filtration area on the westerly side of the village near the northerly shore of a mill pond on Mine Brook, where the sewage is to be purified by intermittent filtration and the effluent discharged into Mine Brook.

The Board has caused the locality to be examined by its engineer and has carefully considered the plans and information submitted therewith.

Mine Brook is at the present time grossly polluted by sewage and manufacturing wastes discharged into the stream in the village of Franklin, and a sewerage system of sufficient capacity for collecting and disposing of this sewage should be constructed as soon as practicable and the further pollution of the stream prevented. There is no doubt that the plan of collecting the sewage and manufacturing wastes in a system of pipe sewers from which all rain water, and, so far as practicable, ground drainage is excluded, as you now propose, is the best plan to adopt in providing a system of sewerage for Franklin; and the best plan of disposing of the sewage will be to apply it intermittently to prepared areas of land having a coarse sandy or gravelly soil, as proposed in the plan now submitted.

Under the present plan, however, the sewage would be delivered at the filtration area at so low a level that it would be necessary to handle much of the soil in order to provide an adequate area of filter beds. It is possible, apparently, by changing the grade of the main sewer, which now has a greater fall than is necessary to maintain a proper current in the sewers, to discharge the sewage upon the filtration area at a higher level than proposed and effect some saving in the preparation of filters; but the proposed filtration area is located close to the town, and according to the plan submitted a large portion of it is less than one thousand feet from the wells of the Franklin Water Company from which a portion of the water supply of the town is drawn. Under these conditions, the

Board does not consider that the use of this area for the disposal of sewage is advisable.

The Board would advise that you cause further investigation to be made of other areas in the valley, with a view to securing a location for the filter beds at a greater distance from the village and at some place where the effluent will not be likely to drain toward a source of water supply.

It is very important, in constructing the proposed sewerage system, to remove the manufacturing wastes which now seriously pollute the stream. It is possible that these wastes contain matters which, if discharged directly into the sewers, would tend to cause obstructions; and the question of providing settling tanks or such other treatment for those wastes as may be necessary to remove matters which the ordinary current of the sewers will not carry along should be considered in designing the sewerage system.

The Board will give you further advice in the matter when you have the results of further investigations to present.

AUG. 2, 1906.

*To the Board of Selectmen of the Town of Franklin.*

GENTLEMEN: — The State Board of Health received from you on July 20, 1906, an application for advice with reference to a proposed system of sewage disposal for the town of Franklin, containing the following outline of your proposed plans: —

Estimated maximum quantity of sewage to be ultimately treated per twenty-four hours by the proposed beds, including the wastes from the Franklin Yarn Company Mills, the Hayward Mills, the American Woolen Mills, and Singleton Worsted Company Mills, about 300,000 gallons.

If necessary, simple and effective preliminary treatment of these manufacturing wastes will be required of the above mills before turning said wastes into the sewer.

A lot covering 10 or 12 acres, to be taken for the disposal beds, located on land belonging to H. T. Hayward, formerly known as the Fisher Farm, lying on the east side of the Ashland Branch of the N. Y., N. H. & H. R.R. The drainage from this land passes in culverts under the railroad embankment into Mine Brook, through which culverts or other similar culverts it is proposed to pass the effluents from the beds.

This location is proposed as a temporary one to meet the present requirements of the town, there being available for future development for disposal of sewage an excellent location just below the village of Unionville, about 11,000 feet distant from the above location on the Hayward land. The elevation of the main outfall sewer as proposed for these initial beds will be high enough to permit of an extension to Unionville.

The accompanying plan, scale 1″ = 40 feet, shows a layout of sixteen beds, each with a bottom area of 10,950 square feet, or approximately ¼ acre,

and two dosing tanks, each containing about 40,000 gallons. The depth of sand and gravel on the beds is to be from 4 feet to 5 feet. The assumed rate of filtration is from 60,000 to 75,000 gallons per day, making the individual capacity of each bed from 15,000 to 18,750 gallons per day. The system of underdrains consists of parallel lines of tile drains, 6 inches in diameter in the upper half and 8 inches in diameter in the lower half, dropping on a grade of 1 foot in 150 feet to the collecting ditch, which discharges through culverts under the railroad embankment into Mine Brook. The walls and floors of the dosing tanks and siphon chambers are to be of concrete, with the proper openings, screens and arrangements for removing the sludge. An area outside of each dosing tank will be prepared to receive the sludge. The main carrier starts with a diameter of 12 inches, reducing to 10 inches. The lateral carriers are all 8 inches, with nine 4-inch outlets onto each bed.

It is proposed to construct the two dosing tanks and siphon chambers and twelve of the beds at once, in accordance with the foregoing plan.

Plans showing the location of the proposed filtration area and the general layout of the proposed filter beds have been submitted by your engineer.

In response to this application, the Board has caused the locality to be examined by its engineer and has considered the plans presented.

The area of filter beds shown upon the plan would, in the opinion of the Board, be sufficient, in the beginning at least, for the purification of the sewage of the portion of the town which they are designed to serve; but much of the land on which the filter beds would be located is now a swamp, and a large portion of the material used in the construction of the filters will have to be obtained from other portions of the area. Soil well adapted to the purification of sewage by intermittent filtration can, however, be obtained on the area which it is proposed to take for sewage-disposal purposes.

The principal objections to the use of this area for sewage disposal, as pointed out in a previous communication, are the proximity of the area to the wells of the Franklin Water Company and its nearness to the village. Portions of the filter beds indicated upon the plans submitted would be within about 500 feet of the nearest dwelling houses, and the location of the filter beds is such that the prevailing winds in summer would tend to carry odors from the filter beds toward these dwellings. The area of the filter beds will in all probability require enlargement at no very distant time in the future, and in that case the filtration area is likely to be brought even nearer to the populated parts of the town.

Under these circumstances, if there were no danger that the disposal of sewage at this place would affect the wells of the Franklin Water Company, the danger that they would be objectionable to a considerable

population would, in the opinion of the Board, make the use of these lands for sewage-disposal purposes unadvisable.

You state in your application that there is an excellent location for filter beds below the village of Unionville, about 11,000 feet distant from the one now proposed; and the Board would recommend that you cause plans to be made without delay for conveying the sewage to the area indicated and disposing of it there by intermittent filtration, and that a careful estimate of the cost of the necessary works be prepared.

When the plans have been made and submitted, the Board will give you further advice as to the disposal of the sewage of the town.

### HAVERHILL.

SEPT. 6, 1906.

To the Hon. ROSWELL L. WOOD, *Mayor of the City of Haverhill.*

DEAR SIR: — The State Board of Health received from you on Aug. 3, 1906, an application for advice relative to a proposed system of sewerage for a portion of the city of Haverhill in the Bradford District near Peabody Brook, containing the following outline of your proposed plan: —

> The present need for sewerage facilities is confined to a few houses in the vicinity of the southerly end of Kimball and Central streets, and is for the removal of house sewage only, as the surface water can readily be disposed of in the natural water courses. The proposed outlet, however, is designed of a capacity to accommodate the sewage of all the territory most easily drained to it, with any development which it seems reasonable to anticipate.

The application is accompanied by a plan of the city engineer, showing the main sewers and outlet of the proposed system, entitled, "Plan of Proposed Sewerage System for a Portion of Ward 7 in the Vicinity of the Peabody Brook, Haverhill, Mass. Robert R. Evans. City Engineer. Scale 200′ = 1″. July, 1906." The plan provides for a system of sewers for the district indicated, to be constructed on the separate plan, having an outlet into the Merrimack River about 400 feet below the power station of the Boston & Northern Railroad, and approximately an equal distance up stream from the mill of the Haverhill Boxboard Company.

The Board has caused the locality to be examined by its engineer and has considered the plan presented.

The area to be provided with sewerage is at the present time very sparsely populated, and the quantity of sewage which will be discharged at the proposed outlet is likely to be small for several years in the future. Though there are considerable areas of flats along the southerly side of the Merrimack River in the neighborhood of Porter's Island, about half

a mile below the proposed outlet, the circumstances are such that it is unlikely that objectionable conditions will be caused by the discharge of sewage at this outlet for several years at least, and it is practicable to extend the outlet into deeper water if it should be found necessary at any time in the future.

In the opinion of the Board, the plan is a satisfactory one for the collection and disposal of the sewage of the district indicated in your application.

## MARION.

OCT. 4, 1906.

*To the Sewer Commissioners and Board of Health of the Town of Marion,* Mr. WILLIAM A. ANDREW, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on March 9, 1906, an application requesting the approval by the Board of the taking, under the provisions of chapter 49, section 1, of the Revised Laws of Massachusetts, for the purification and disposal of sewage, of certain lands in the town of Marion, located on what is known as the "Mill place," about 2,000 feet west of Mill Street, between said street and the New York, New Haven & Hartford Railroad, about one mile south of the railroad station at Marion, the area to be taken being described in the application and shown upon a plan submitted therewith.

Acting under the authority of the statute above mentioned, the State Board of Health gave a public hearing at its office, Room 143, State House, on Thursday, Oct. 4, 1906, notice of the hearing having been given by publication in a newspaper circulating in the town of Marion. At this hearing it was stated that the plan provides for taking an area of 2½ acres to allow for the enlargement of the filters in the future, and that it is proposed to construct immediately filter beds aggregating 1 acre in area for the purification of the sewage.

The area of filter beds which it is proposed to construct in the beginning is, in the opinion of the Board, a reasonable provision for the purification of the sewage of the village at the present time, and the additional area to be taken will allow for the enlargement of the filters if necessary in the future.

The Board, having caused the area to be examined by one of its engineers and considered the information presented at the hearing, hereby approves the purchase or taking of the lands now or formerly of Robert B. Hiller and Isaac E. Hiller of Marion, — a total of 2½ acres, as shown upon a plan submitted with your application, entitled, "Marion Sewerage System. Map showing Location, Size and Approximate Depth of Sewers. Scale 1″ = 200′, January 1906. Coffin & Thorpe, Civil and Hyd. Engineers, 53 State St., Boston," said land being bounded, measured and described as follows: —

A certain tract of land situate about 2,000 feet west of Mill Street on what is known as the "Mill place" and more particularly described and bounded as follows, viz.: Beginning at a stake in the northeast corner of the described premises, thence south 27° 30′ east 272.25 feet, thence south 62° 30′ west 400 feet, thence north 27° 30′ west 272.25 feet, thence north 62° 30′ east 400 feet to the point of beginning; together with a right of way 20 feet wide beginning at a point in the easterly line of said lot 129 feet from said northeast corner and extending north 66° 25′ east 400 feet across said Hiller's land to the land of the heirs of Barnabas Holmes, the above being the northerly line of said right of way.

## MILFORD.

JULY 12, 1906.

*To the Sewerage Committee of the Town of Milford.*

GENTLEMEN: — The State Board of Health received from you, through your engineer, on June 16, 1906, the following application requesting approval by the Board of a plan of sewerage and sewage disposal for the town of Milford: —

By vote of the sewerage committee of Milford, Mass., I am authorized to present for your consideration the report herewith enclosed, on a system of sewerage and sewage disposal for the town of Milford.

It is the desire of the committee to construct, this season, the disposal plant and such portion of the interception system as will remove the nuisance now existing in the Charles River.

The Board has caused the locality to be examined by its engineer and has examined the plans and report presented.

The plan in general provides for collecting the sewage from the thickly built up part of the town in a system of pipe sewers and for conveying it by gravity to an area of land near the westerly bank of Charles River in the town of Hopedale about half a mile south of the Milford boundary on that side of the river, where it is proposed to purify it by intermittent filtration and discharge the effluent into the river.

The main sewer from the town to the filtration area passes through Depot Street, South Main Street and lands adjacent thereto, and no portion of the works in the town of Hopedale is at a greater distance than one-half mile from Charles River.

In accordance with the provisions of chapters 343 and 458 of the Acts of the year 1906, a hearing was given by the State Board of Health at its office on July 5, 1906, with reference to the approval of the proposed plans of sewerage and sewage disposal for the town of Milford, after due notice of the hearing had been given by the Board by publication of such notice in two daily papers and one weekly paper published in the

town of Milford. At this hearing no one appeared to oppose the approval of the plans presented.

After the hearing the Board voted to approve the plans of sewerage and sewage disposal presented by the sewerage committee of the town of Milford, as outlined herein. The plans are described in detail in a report of your engineer, entitled: "Report to the Sewerage Committee of the Town of Milford on a System of Sewerage and Sewage Disposal by F. A. Barbour, Engineer, Boston, Mass.," dated June 13, 1906, and are shown upon the plans submitted therewith, the general plan bearing the following title: "Milford Sewerage System. Plan showing Lateral and Intercepting Sewers and Location of Pumping Station and Disposal Plant. Scale 1 Inch = 400 Feet. F. A. Barbour, Engineer, Boston, Mass. June — 1906."

The plan of applying the sewage to the filter beds automatically and in rotation by a mechanical device seems likely to depend largely upon the care with which this device is maintained. The works for the discharge of the sewage to the different beds should be so constructed that in case the automatic device fails to operate satisfactorily it will be practicable to provide without difficulty for the proper dosing of the beds.

## Millbury.

Nov. 1, 1906.

*To the Board of Selectmen of the Town of Millbury.*

Gentlemen: — In response to your request for advice as to the condition of the Blackstone River and information as to the causes of pollution thereof, the State Board of Health has caused the stream to be examined and has considered the results of the numerous analyses of its waters and the information presented in the municipal records of the sewerage and sewage-disposal works of the city of Worcester.

Similar requests from your board have been considered by this Board on two previous occasions, — once in the year 1892, and again in 1895. In the former year the Board found that the river was seriously and offensively polluted by sewage, and in the year 1895 its condition was found to be practically the same as at the previous time.

Since 1895 it appears, from the municipal reports of the city of Worcester, that a great amount of work has been done in separating the sewage from the storm water, and that at the present time more than half of the total length of sewers is operated upon the separate plan. Many miles of storm-water drains are in use, and intercepting sewers have been completed which intercept the dry-weather flow of sewage which formerly ran into Mill Brook.

Under the conditions existing in 1895, when the sewage was discharged into Mill Brook, the dry-weather flow only of that stream was treated,

any excess of flow due to rain or melting snow being allowed to flow directly into the river. At the present time all of the sewage collected in the intercepting sewers is conveyed to the disposal works and treated; but the overflow from the combined sewers (which form 46 per cent. of the total length of sewers) at times of storm or when snow is melting rapidly is discharged into the Blackstone River or its tributaries without treatment.

Under these conditions the volume of sewage treated at the disposal works has been reduced, and during 1905 was slightly less than at the time the last previous reply of the Board upon this subject was made, in 1895.

In addition to providing for the treatment of the sewage by chemical precipitation, the city has, since 1898, constructed filter beds from time to time, until at the present time about 36 acres of filter beds are available and are used for the purification of a portion of the sewage by intermittent filtration; and it appears from the report of the superintendent of sewers of Worcester for the year ending Nov. 30, 1905, that a little over 24 per cent. of the total flow of sewage was applied to these filter beds during that year.

While these great improvements have been made in the sewerage system of the city, and a large area of filter beds, capable of efficiently purifying sewage, has been provided, it is to be noted that the population of the city has increased in the ten years from 1895 to 1905 about 30 per cent., and that, while there has been a slight decrease in the quantity of sewage, due to the diversion of the sewage from Mill Brook and the exclusion of storm water from many of the sewers, there has, on the other hand, been a very decided increase in the quantity of organic matter in the sewage and in the effluent from the chemical precipitation works. The analyses indicate that the quantity of organic matter now discharged into the river in the effluent from the precipitation works (which is about three-quarters of all of the effluent discharged into the river by the city of Worcester) is about double the quantity so discharged ten years ago.

Judging from the quantity of organic matter discharged into the river from the Worcester sewage-disposal works, there is no reason to expect at the present time an improvement in the condition of the river below Worcester, and there is no evidence that any improvement has taken place. On the contrary, chemical analyses of the water of the river collected at various points below the Worcester sewage-disposal works show that the condition of the river is worse than at the time of either of the previous examinations; and an inspection of the river shows that it is still offensive and a nuisance for a long distance below the Worcester sewage-disposal works.

Examinations of the water of the Blackstone River above the Worcester sewage-disposal works, but below the city, show that the river in this region is also more polluted than was the case in 1895, due probably in part to the overflow of sewage from the city sewers in times of storm and in part to sewage and manufacturing wastes discharged directly into the stream or its tributaries from buildings and factories.

The chief cause of the pollution of the Blackstone River, however, is the discharge of putrescible organic matter in the effluent of the sewage-precipitation works of the city of Worcester.

### Newburyport.

May 8, 1906.

To Mr. George H. Welch, *Chairman of the Sewer Committee of the City of Newburyport.*

Dear Sir: — The State Board of Health received from you on April 5, 1906, an application for the approval by this Board, under the provisions of section 1 of chapter 233 of the Acts of the year 1889, of the discharge of the sewage of a section of Merrimack and Ashland streets into the Merrimack River at a point near its southerly bank between Ashland and Forrester streets, as shown upon a plan accompanying your application, and the Board has caused the locality to be examined by one of its engineers.

The district from which it is proposed to discharge sewage into the river at this outlet includes a low area along Merrimack Street and near the northerly ends of Forrester and Ashland streets, which is served by a low-level sewer, the sewage of which at the present time is pumped into the main intercepting sewer by a pump operated by power from the city water works.

It appears that a very large quantity of ground water leaks into the sewer, making the cost of pumping considerable, and that the present pumps do not operate properly at all times, resulting in objectionable conditions in the neighborhood.

While the quantity of sewage that would be discharged into the river from this sewer is not considerable, as compared with the flow of the stream, objection is made to this method of disposal; and there is danger that, unless the sewer should be carried to a much greater distance from shore than indicated in the plan submitted, sewage would return and collect on the flats near the outlet.

The Board does not deem it advisable that sewage should be discharged into the river in front of the city and does not approve the plan presented. It is probable that, by installing more efficient machinery or power and reconstructing the sewer or such portions of it as may be

necessary to prevent excessive leakage, the sewage can be disposed of without difficulty and at small expense by pumping into the high-level sewer, as at present.

## NORTHBRIDGE.

MARCH 8, 1906.

*To the Sewer Commissioners of the Town of Northbridge, Mr. E. GLUECK, Chairman.*

GENTLEMEN: — The State Board of Health received from you on Jan. 27, 1906, an application requesting the approval by the Board of the taking, under the provisions of chapter 49, section 1, of the Revised Laws of Massachusetts, for the purification and disposal of sewage, of certain lands in the town of Northbridge, located on the northeasterly side of the Providence & Worcester Division of the New York, New Haven & Hartford Railroad, about a mile northeast of the village of Linwood, the area to be taken being described in the application and shown upon plans submitted therewith.

Acting under the authority of the statute above mentioned, the State Board of Health gave a public hearing at its office, Room 143, State House, on Thursday, March 1, 1906, at 11 A.M., notice of the hearing having been given by publication in two newspapers circulating in the town of Northbridge. At this hearing it was stated that your proposed plan is to construct at once 6 acres of filter beds, in addition to sludge beds for the purification of the sewage, and the plan shows provision for enlarging the area of filter beds in future to about 15 acres.

The area of filter beds which it is proposed to construct in the beginning (6 acres) is, in the opinion of the Board, a reasonable provision for present needs; and if the works shall be properly constructed and maintained and the area of filter beds enlarged from time to time as becomes necessary, the sewage of Northbridge can, in the opinion of the Board, be purified efficiently upon this area until the population becomes much greater than at present.

The Board, having caused the area to be examined by one of its engineers and considered the information presented at the hearing, hereby approves the purchase or taking of the lands now or formerly of Patrick Driscoll, Margaret A. Driscoll, Nora Driscoll and Arthur F. Whitin, a total of 40½ acres, more or less, as shown upon a plan filed with your application, entitled "Plan of Filtration Area. Village of Whitinsville. Town of Northbridge, Mass. McClintock and Woodfall, Consulting and Civil Engineers. 15 Court Sq., Boston, Mass. 1906," said lands being bounded, measured and described as follows: —

*Land of Patrick Driscoll.*

Beginning at a point in the easterly location line of the N. Y., N. H. and H. R.R. and the wall marking the division line between land of Patrick Driscoll and land of Arthur F. Whitin, thence, S. 4° E. 924 feet with the wall on the line of said railroad to a bend in the wall; thence, S. 8° W. with the said wall on the line of said railroad $368\frac{9}{10}$ feet to a corner of fence; thence, S. 77° E. $978\frac{1}{10}$ feet to a stake and stones; thence, N. $21\frac{1}{2}$° E. $456\frac{7}{10}$ feet to a stake and stones; thence, N. 3° W. $302\frac{9}{10}$ feet to a corner of wall at the lane; thence, N. $81\frac{1}{2}$° W. $338\frac{6}{10}$ feet by land of said Whitin to an angle in the wall of said lane; thence, N. 47° W. $194\frac{6}{10}$ feet by land of said Whitin to a point; thence, S. 43° W. $207\frac{2}{10}$ feet by land of Margaret A. Driscoll to a stone bound; thence, N. 48° W. $208\frac{8}{10}$ feet by land of said Margaret A. Driscoll to a stone bound; thence, N. 43° W. by land of Nora Driscoll $204\frac{6}{10}$ feet to a point; thence, N. 43° E. $213\frac{2}{10}$ feet by land of said Nora Driscoll to a point in the wall on said lane and land of said Whitin; thence, N. 43° W. with said wall and land of said Whitin 431 feet to point of beginning, containing $19\frac{1}{2}$ acres.

*Land of Margaret A. Driscoll.*

Beginning at the northwesterly corner of the herein-described land and at land of Nora Driscoll and land of Arthur F. Whitin, thence, S. 47° E. by land of said Whitin $208\frac{6}{10}$ feet; thence, S. 43° W. by land of Patrick Driscoll $207\frac{2}{10}$ feet to a stone bound; thence, N. 48° W. by land of said Patrick Driscoll $208\frac{8}{10}$ feet to a stone bound; thence, N. 43° E. by land of Nora Driscoll $213\frac{2}{10}$ feet to the point of beginning, containing 1 acre.

*Land of Nora Driscoll.*

Beginning at the northwesterly corner of the herein-described parcel of land at a point located in the wall marking the division line between land of Nora Driscoll and land of Arthur F. Whitin, and distant S. 43° E. 431 feet by said wall from the easterly location line of the N. Y., N. H. and H. R.R., thence, S. 43° E. with said wall and land of said Whitin $191\frac{4}{10}$ feet; thence, S. 47° E. with said wall and land of said Whitin $13\frac{2}{10}$ feet to land of Margaret A. Driscoll; thence, S. 43° W. by land of said Margaret A. Driscoll $213\frac{2}{10}$ feet to a stone bound; thence, N. 43° W. $204\frac{6}{10}$ feet by land of Patrick Driscoll; thence, N. 43° E. by land of said Patrick Driscoll $213\frac{2}{10}$ feet to point of beginning, containing 1 acre.

*Land of Arthur F. Whitin.*

Beginning at a point in the easterly location line of the N. Y., N. H. and H. R.R. and the wall marking the division line between land of Patrick Driscoll and land of Arthur F. Whitin, thence, S. 43° E. with said wall and land of Patrick Driscoll and land of Nora Driscoll $622\frac{4}{10}$

feet; thence, S. 47° E. by land of Nora Driscoll, land of Margaret A. Driscoll and land of Patrick Driscoll 416$\frac{5}{10}$ feet to an angle in the wall; thence, S. 81½° E. by land of Patrick Driscoll 338$\frac{6}{10}$ feet to a corner of the wall at the lane; thence, N. 4½° W. 1,111$\frac{6}{10}$ feet to a point; thence, S. 87° W. 998 feet to the easterly location line of the N. Y., N. H. and H. R.R.; thence, S. 4° E. on line of said railroad 302 feet to place of beginning, containing 19 acres.

## PEABODY.

MARCH 1, 1906.

To Mr. A. N. JACOBS, *Chairman, Board of Selectmen, Peabody, Mass.*

DEAR SIR: — The State Board of Health received from you on Feb. 20, 1906, an application for advice as to a proposed system of sewerage and sewage disposal for the town of Peabody, accompanied by plans and profiles of the proposed sewers and by a report of your engineer describing the proposed works.

The plan in general provides for a separate system of sewers to collect the sewage and manufacturing wastes of the town and convey them to an outlet into the main trunk sewer now being built by the city of Salem under the provisions of chapter 353 of the Acts of the year 1901 and which Peabody is authorized to use as an outlet for its sewage under the provisions of chapter 312 of the Acts of the year 1904.

The Board has examined the plans and information submitted therewith and is of the opinion that works constructed with proper care in general accordance with these plans will provide satisfactorily for the removal and proper disposal of the sewage and manufacturing wastes of the town of Peabody, making allowance for a considerable increase in the population and in the quantity of sewage to be disposed of in the future.

It will probably be necessary, before admitting some of the manufacturing wastes to the sewers, to provide for the exclusion of matters which the ordinary current of the sewer will not carry along, or which may be seriously objectionable in the sewers from any other cause; and provision should be made, so far as practicable, for the possibility of such treatment in determining the location and depth of tributary sewers.

In order to avoid unnecessary expense in the maintenance of the system and to maintain the capacity for the reasonable future increase in the quantity of sewage, care should be taken, in the construction of the works, to exclude from the sewers all surface water, and, so far as practicable, ground drainage, since these waters can, if unpolluted by sewage, be discharged into local water courses without objection.

## PEABODY (A. C. LAWRENCE LEATHER COMPANY).

NOV. 1, 1906.

*To the A. C. Lawrence Leather Company, Peabody, Mass.,* MR. G. W. HOLLIS, *Director.*

GENTLEMEN: — The State Board of Health received from you on October 17 a plan of a tank designed to take care of all of the sewage of the Waters River tannery at Peabody, and subsequently, on October 27, a plan was submitted showing a discharge pipe leading from this tank to a cove in Waters River near Liberty Street in Peabody.

It appears that the tank is designed for the disposal of the sewage of from 100 to 150 operatives to be employed in the new tannery, and that it is also to receive the water used in washing floors, but not rain water.

The Board has caused the locality to be examined by its engineer and has examined the plans presented, and concludes that the discharge of sewage, after passing through the proposed tank, into Waters River would tend to pollute the shores and bed of that stream and create objectionable conditions. In the opinion of the Board, further purification of the sewage will be necessary before the effluent from the proposed tank can be discharged into Waters River without objection.

## REVERE.

DEC. 6, 1906.

*To the Board of Health of the Town of Revere.*

GENTLEMEN: — The State Board of Health received from you on Oct. 22, 1906, the following communication relative to an alleged nuisance in the neighborhood of the Point of Pines, in which you request the assistance of the Board in remedying the objectionable conditions: —

We have received a petition from a number of residents of the Point of Pines district, this town, asking for the relief of grievous distress, caused them by the emptying of sewage from the city of Lynn into the Saugus River, opposite said Point of Pines. We have considered the matter and believe the conditions exist, as stated, refuse from sewage being thrown on water front at Point of Pines and a bad and noxious odor being smelt during certain winds. Now, we call your attention to the above, believing that it comes directly under your jurisdiction, and hoping that you will take steps to relieve our citizens of the distressing conditions set forth.

In response to your request the Board has caused the locality to be examined by its engineer and has considered the available information as to the conditions resulting from the discharge of the sewage of the city of Lynn into Lynn harbor north of the mouth of the Saugus River.

The results of the examination, made in the month of November, did not show that sewage from the city of Lynn was affecting visibly the

condition of the shores of the Point of Pines, nor that, under the conditions then existing, any odor from the neighborhood of the Lynn sewer outlet was noticeable along the Revere shores. While the conditions along the shores of Revere at this time were not objectionable, it is evident that large quantities of sewage have been deposited upon the flats north of the Saugus River in the neighborhood of the Lynn sewer outlet, from which objectionable odors may arise in the summer season.

The Board will make a further examination in the warmer portion of the year, if you so request, and, if objectionable conditions are found, will take such action as it can in the matter.

### Rockland (Factories of Rice & Hutchins and J. W. Spence).

April 5, 1906.

*To the Board of Health of the Town of Rockland.*

Gentlemen: — The State Board of Health has considered your application for advice with regard to the disposal of the sewage of the factories of Rice & Hutchins and of J. W. Spence in Rockland, and has caused an examination of the localities in which these factories are situated to be made by one of its engineers.

The sewage of the J. W. Spence factory, located at the corner of Park and Howard streets, is discharged into a large cesspool in the rear of the building; and it does not appear that there have been any complaints regarding the disposal of the sewage at this factory, the complaint being as to the lack of ventilation in the workrooms.

At the Rice & Hutchins factory there is a large privy vault, the contents of which are removed from time to time, but it appears that overflows occur and cause a nuisance in the neighborhood. The factory is situated in a depression through which a small stream runs, and the ground is saturated with water, so that the vault stands nearly full at all times. If the vault were made tight and were cleaned out with sufficient frequency to prevent overflows, much of the objection now caused by the disposal of sewage from this factory could be prevented; and this is probably the least expensive plan of disposing of the sewage of this factory at the present time.

In this case, as in the case of other factories and buildings in Rockland examined from time to time at your request, it is impracticable to dispose satisfactorily of the sewage upon the very limited area available within the factory grounds or its neighborhood; and the best and only practicable plan of dealing satisfactorily with the very objectionable conditions now existing at several localities in the village of Rockland is to construct sewers for the removal of the sewage to a proper place of disposal, as you have been advised in previous communications.

The question of the need of further ventilation in these factories should be referred to the district police, who have charge of the enforcement of laws relating to such matters.

## Rutland (Prison Camp and Hospital).

Aug. 2, 1906.

*To the Board of Prison Commissioners, Mr.* Frederick G. Pettigrove, *Chairman.*

Gentlemen: — The State Board of Health received from you on July 10, 1906, an application for advice as to a proposed system of sewage disposal for the prison camp and hospital in Rutland, accompanied by plans of the proposed works. These plans provide for conveying the sewage to a filtration area located on the westerly bank of the Ware River, near the foot of the hill upon which the hospital building is located.

The Board has caused the locality to be examined by its engineer and has examined the plans presented, and is of the opinion that they provide adequately for the proper disposal of the sewage from a population of about 150. The area of filter beds will require enlargement when the population increases beyond that number.

The location of the filter beds is such that it is unlikely that odors from them will be noticeable at any of the buildings in this region, and they are at a sufficient distance from the well which it is proposed to use as a source of water supply to avoid any danger that the quality of the water may be affected thereby.

## Taunton.

July 12, 1906.

*To the Board of Sewer Commissioners of the City of Taunton.*

Gentlemen: — The State Board of Health has considered your petition of May 3, 1906, requesting of the Board a further extension of the time for the completion of the sewage-disposal works for the city of Taunton, and also the information contained in your communication of June 20, from which it appears that no work has yet been done in the construction of the main intercepting sewer necessary to convey the sewage from the present outlets into the Taunton River down to the point at which it is proposed to locate the pumping station, and that very little has been done toward completing the removal of the sewage from Mill River. But, in view of the various circumstances set forth in your latest communication, the Board has voted to extend the time for the completion of the sewerage and sewage-disposal system of the city of Taunton to July 1, 1907, and that, if at that time the city has shown due diligence in the construction of the main intercepting sewer necessary to convey the sewage from the present outlets into the Taunton

River down to the point at which it is proposed to locate the pumping station, and in completing the removal of the sewage from Mill River, the Board will then consider the further extension of the time for the completion of the sewerage and sewage-disposal works of the city, as provided in the plans approved by order of this Board on July 15, 1897, but not beyond July 1, 1910.

OCT. 4, 1906.

*To the Board of Sewer Commissioners of the City of Taunton.*

GENTLEMEN: — The State Board of Health received from you on Sept. 15, 1906, an application for the approval of a new temporary outlet and permanent overflow for the sewerage system of the city of Taunton, accompanied by plans showing certain proposed changes in the location of the main sewer in the neighborhood of the pumping station lot and the location of the proposed new overflow and temporary outlet.

The plans approved by this Board on July 15, 1897, provide for a temporary overflow from the main sewer, passing along the northerly side of the pumping station lot close to the municipal lighting plant and discharging into the river. Under these plans this overflow is to be used temporarily as a main outlet for sewage; but after the construction of the pumping station and the works for disposing of the sewage upon the disposal area in Berkley, this overflow sewer is to be used for the disposal of sewage only in emergencies, such as an accident to the pumping station, pumps or force main.

By the plans now presented it is proposed to omit the construction of this overflow sewer and temporary outlet along the northerly side of the pumping station lot, and to extend the sewer along the private way on the westerly side of the lot to the new channel of Cobb Brook, which is now being built from the present channel at a culvert under the New York, New Haven & Hartford Railroad along the southerly side of the pumping station lot to the river, and to discharge the sewage temporarily into this channel at a point about 40 feet below the private way and 300 feet from the river.

The new channel of Cobb Brook, according to the plans presented, is to be constructed of concrete, having a width of 5 feet and a depth of 8 feet, and its bottom from the neighborhood of the proposed outlet to the Taunton River will be about 4 feet below the ordinary level of low tide. It is proposed to provide a tide gate above the sewer outlet to prevent sewage from being carried up the stream at times of dry weather, since the dry-weather flow of the brook is small as compared with the quantity of sewage that would be discharged into it while used as a temporary outlet for sewage.

The Board has caused the locality to be examined by its engineer and

has considered the plans presented, and is of the opinion that the proposed outlet will not be objectionable as a place for the occasional discharge of sewage at times of emergency, as contemplated in the plan of sewerage and sewage disposal of the city approved by the Board in 1897.

The outlet will, however, be used as a temporary point of discharge for the whole flow of the main sewer of the city until the extension of the sewage-disposal works, and under the circumstances it is important to avoid danger of creating objectionable conditions in the neighborhood of the outlet during the period of such use; and if sewage should be discharged into the open channel of the brook, as now proposed, it might cause an objectionable odor in the neighborhood. In the opinion of the Board, if this objectionable condition arises it can be avoided by covering the channel of the brook from the neighborhood of the private way to the river and keeping it covered during the period of such use, and by providing for flushing out or cleaning the channel from time to time during this period to prevent objectionable deposits from forming therein.

With such modifications as above suggested, if found desirable, the Board hereby approves the location of an overflow for the sewage of the city of Taunton into Cobb Brook at the point proposed, to be used only in cases of emergency after the construction of the pumping station, force main and sewage-disposal works in Berkley, and approves the discharge of the whole flow of the main sewer temporarily into this channel.

### West Bridgewater (Howard Seminary).

Nov. 1, 1906.

*To the Board of Trustees of the Howard Seminary, West Bridgewater, Mass.*

Gentlemen: — The State Board of Health has considered the plans presented by your engineer for the disposal of the sewage of the Howard Seminary in West Bridgewater and has caused the locality to be examined by one of its engineers.

The plans provide for collecting the sewage in a tank to be located on the seminary grounds about 200 feet from the buildings, whence the sewage will flow to a dosing tank, from which it will be discharged automatically through a 6-inch pipe about 400 feet in length to a sand-filter bed, whence the effluent will flow to the Town River. The filter bed shown on the plan has an area of about 5,000 square feet and a depth of 4 feet. The sewage is to be applied to the filter bed through distributing pipes laid about one foot beneath the surface.

In the opinion of the Board, works constructed in accordance with these plans will be of sufficient capacity for the present requirements of the institution in the matter of sewage disposal; and if these works are

properly maintained and the pipes through which the sewage is discharged into the sand are relaid at intervals when necessary, the works will operate satisfactorily and will not cause objectionable conditions in the neighborhood.

### Westfield.

Aug. 2, 1906.

*To the Board of Sewer Commissioners, Westfield, Mass.*

Gentlemen: — The State Board of Health has considered the application presented by the town engineer for advice as to certain storm-water drains for portions of the town of Westfield and the plans submitted therewith and has caused the locality to be examined by its engineer.

The plans submitted show four systems of drains designed to remove storm water from territory lying on the north side of the Westfield River and to discharge it into the river at four outlets, two of which are located above the dam. It appears that sewers have already been constructed for the removal of sewage proper from this territory and that the drains are designed for the removal of storm water and ground drainage only.

The Board is of the opinion that the capacity of the proposed drains is sufficient for the present requirements of the districts which they are designed to serve, and that the proposed outlets are suitable ones for the disposal of storm water and are unlikely to cause objectionable conditions in their vicinity if sewage is kept out of the drains. In the future, when the territory served by these drains becomes more thickly populated, the capacity of some of the drains may become overtaxed; but in that case additional outlets can be provided without serious difficulty, and it does not appear to be necessary under the circumstances to construct larger drains than those proposed in any of these districts at the present time.

### Weymouth (Stetson Shoe Company).

July 5, 1906.

*To the Board of Selectmen of the Town of Weymouth,* Mr. Bradford Hawes, *Secretary.*

Gentlemen: — The State Board of Health received from you on May 14, 1906, a communication requesting its advice as to the disposal of the sewage of the Stetson Shoe Company's factory in South Weymouth, and subsequently, on June 29, the engineer of the company submitted plans of a proposed system of sewage disposal for this factory.

These plans provide in general for collecting the sewage in a tank and conveying it through an 8-inch sewer to filter beds located about a quarter of a mile southwest of the buildings, where it is to be purified by intermittent filtration through the gravelly soil of which the filters are to be built.

The Board has examined the plans presented, and concludes that in

general they provide satisfactorily for the disposal of the sewage from the Stetson Shoe Company's factory.

The soil of the gravel ridge which is to be used in the construction of the filters is well adapted for the purification of the sewage by intermittent filtration; and the area of the filter beds, as shown on the plan, is sufficient for the present requirements of the factory.

It does not appear to be essential in this case to provide carriers with concrete bottoms for the distribution of the sewage, since, if the sewage should be discharged upon the surface at two or three points along the sides of the beds, a sufficient distribution would be effected.

## WINCHENDON.

MARCH 1, 1906.

*To the Sewerage Committee of the Town of Winchendon.*

GENTLEMEN: — The State Board of Health received from you on Jan. 19, 1906, an application for advice with reference to a proposed system of sewerage and sewage disposal in the town of Winchendon, and subsequently, on February 20, plans were received showing outlines of the proposed works. These plans provide for collecting the sewage from all of the thickly settled portions of the town in the valley of Millers River into a system of pipe sewers, through which it is proposed to convey it to filter beds to be constructed on land on the southerly side of the river below the village, where the sewage is to be purified by intermittent filtration and the effluent discharged into the river. The plans also show an outlet for the main sewer into Millers River below the last dam in the village, through which it is proposed to discharge the sewage untreated into the river for such time as that method of disposal may be permissible.

The Board has caused the locality to be examined by one of its engineers and has considered the plans submitted.

There appears to be no serious difficulty in collecting the sewage in sewers laid upon suitable grades and conveying it by gravity to the proposed disposal area and outlet; and the best practicable plan of purifying the sewage will be to filter it through beds of sand or gravel, as provided in the proposed plans.

An examination of the proposed filtration area shows that beneath a rather deep layer of loam the soil is favorable for the purification of sewage by intermittent filtration. An examination of areas lying north of the river in this neighborhood shows that the soil of these lands is also well suited for the purification of sewage by intermittent filtration, and that the depth of loam is in general much less than on the lands on the southerly side of the river. This area is in some respects also more

desirable than the area on the southerly side of the river; and the Board would advise a further investigation, with a view to its use for the purification of the sewage of the town.

The Board has also considered the question of the temporary discharge of the sewage into Millers River. If all of the sewage of the town of Winchendon should be discharged into Millers River, it would seriously pollute the stream and probably create a nuisance immediately below the town; and, in the opinion of the Board, the purification of the sewage will be necessary, though it will probably be permissible to discharge the sewage directly into the river, for a time at least, until sewers have come into general use.

When you have made further investigations and prepared plans as to the disposal of the sewage the Board will, upon application, give you further advice in the matter.

## PUBLIC INSTITUTIONS.

The following is the substance of the action of the Board during the year in reply to applications for advice under the provisions of section 4 of chapter 75 of the Revised Laws: —

### CANTON (MASSACHUSETTS SCHOOL AND HOME FOR CRIPPLED AND DEFORMED CHILDREN).

JAN. 6, 1906.

*To the Board of Trustees of the Massachusetts School and Home for Crippled and Deformed Children, Mr. FRANCIS HURTUBIS, Jr., Secretary.*

GENTLEMEN: — The State Board of Health received from you on Jan. 3, 1906, the following communication, requesting its advice as to a proposed location for a school and home for crippled and deformed children: —

The Board of Trustees for the Massachusetts School and Home for Crippled and Deformed Children has instructed me to request your Board to direct one of its engineers to examine property belonging to one Herbert T. Seavey, situated in the town of Canton, and to furnish this Board with his opinion upon the question of the suitableness of said property as a site for the School and Home for Crippled and Deformed Children.

The area indicated is located in the extreme southerly part of the town of Canton, lying east of Washington Street and just north of the boundary line between Canton and Stoughton, and the Board has caused this area to be examined by one of its engineers.

Water for the supply of the proposed school and home — if this location should be selected — could best be obtained from the water works

of the town of Canton, the pipes of which are laid in the neighboring streets.

As regards sewage disposal, definite advice cannot be given without further investigation. A suitable place for the disposal of the sewage can be found in the lower part of the area, and it is probable, judging from the surface indications, that coarse sand or gravel suitable for sewage purification will be found there. If not, suitable material can be obtained in another part of the area and the necessary filter beds constructed therewith.

The Board sees no objection to the use of these areas for the institution mentioned so far as the question of water supply or the proper disposal of sewage may be concerned.

### WRENTHAM (NEW SCHOOL FOR THE FEEBLE-MINDED).

DEC. 6, 1906.

*To the Trustees appointed by the Governor to establish a School for the Feeble-minded.*

GENTLEMEN: — In compliance with your request for approval by this Board, under the provisions of chapter 75, section 4, of the Revised Laws, of the taking of a certain tract of land in Wrentham as a location for a new School for the Feeble-minded, the Board has caused an examination of the land to be made, the general outline of which is indicated upon a plan submitted by you.

The tract comprises an area of about 200 acres, lying in Wrentham west of the Boston and Providence turnpike, about one mile north of Wrentham village.

An excellent water supply can probably be obtained from the town of Wrentham in case the works now contemplated by that town shall be constructed; but if not, it appears to be practicable to obtain water from the ground within the limits of the area indicated. Much of the land within the area contains soil of suitable quality for the disposal of sewage; but the Board would advise that both the source of water supply and a plan of sewage disposal be determined upon before the construction of buildings shall be begun.

The Board has voted to approve the proposed location.

# Examination of Public Water Supplies.

## EXAMINATION OF PUBLIC WATER SUPPLIES.

The number of sources of public water supplies in use during the year 1906 was 260. Nearly all of these sources of supply have been examined chemically, and bacterial or microscopical examinations have also been made of many of them. In the following tables are given summaries of the results of the chemical analyses of the water of the principal sources of supply, the first table containing the averages of chemical analyses made during the year of the various surface-water supplies, and the second, analyses of the ground-water supplies. Descriptions of changes in or additions to the sources of supply are given in the following notes, together with any facts of special interest regarding the sources.

*Amesbury.* — The sources of supply are two systems of wells, one located near Market Street supplying the high-service and the other near Main Street supplying the low-service system.

During the winter of 1905–06 there were several cases of typhoid fever in the town and an investigation was made of the water-supply system. It appeared that during a fire, water from Powow River was pumped into a system of pipes separated from the town mains by a check valve and there was a possibility that the polluted waters of Powow River had entered the distributing system. It was also found that the water of a brook flowing near the Market Street pumping station had been admitted into the wells. A copy of the advice of the Board to the board of health of Amesbury relative to the condition of the water supply may be found on page 71.

*Ayer.* — The original source of supply was a large well situated near a stream flowing from Sandy Pond. The yield of this well became insufficient for the supply of the town, and during the past year 28 tubular wells have been driven along the shore of the stream about 1,600 feet below the old well. The wells are located from 60 feet to 80 feet from the edge of the stream and are driven to a depth of about 35 feet.

*Concord and Lincoln.* — The towns of Concord and Lincoln are supplied with water from Sandy Pond in Lincoln. The statute under which water is taken provides that if the water of the pond shall prove insufficient for both towns, the town of Lincoln shall be first supplied. An application was received in the spring of 1906 requesting the advice of the Board relative to the capacity of the pond to supply both of the towns. A copy of the advice of the Board may be found on page 93.

*Dracut.* (*Dracut Water Supply District.*) — The village of Collinsville in the town of Dracut has been supplied with water for several years by the American Woolen Company. Works for the supply of the Dracut Water Supply District, which includes the principal part of the population not already supplied, were constructed during 1906. The source of supply is a system of tubular wells in the valley of a small brook. The wells are driven to depths of from 20 feet to 30 feet. A copy of the advice of the Board relative to the use of this source for the supply of the district may be found on page 82.

*Edgartown.* — Works for the supply of the town of Edgartown were constructed by the Edgartown Water Company during 1906. The source of supply is a system of tubular wells near the most northerly arm of Herring Pond, 2½ miles from the center of the village. There are no possible sources of pollution in the vicinity of the wells. A copy of the advice of the Board relative to the use of water from this source for the supply of the town may be found on page 85.

*Franklin.* — During the past year investigations have been made relative to obtaining a new supply for the town of Franklin from wells on the shore of Beaver Pond. A copy of the advice of the Board relative to the probable quality and quantity of the water obtained from this location may be found on page 88. The construction of the works for supplying the town from the new source was begun late in the season of 1906, and was not completed at the end of the year.

*Lynn.* — The water of the Saugus River — one of the sources of water supply of Lynn — is contaminated by sewage from the towns of Reading and Wakefield. A plan was submitted to the Board providing for the construction of a pipe line or conduit to intercept certain branches of the river which receive less pollution than the main stream, and to discontinue the use of the main stream as a source of supply. A copy of the advice of the Board relative to this plan may be found on page 95.

*Marblehead.* — The sources of supply are two wells in the valley of Forest River in Salem. The water from both of the wells contains an excessive quantity of iron, and the water supplied to the town is unfit for many domestic purposes. A copy of the advice of the Board relative to the quality of the water of the wells and as to the possibility of its improvement may be found on page 101.

*Maynard.* — Water for the supply of Maynard is drawn by gravity from White Pond to a pumping station about 2¾ miles from the pond, where it is pumped to an open distributing reservoir. The pipe line from the pond to the pumping station is of earthen pipe which has become partially filled with sand so that its capacity is much reduced, and in places there is a leakage from the pipe. The quantity of water delivered at the pumping station has been insufficient for the supply of the town and

polluted water from the Assabet River has at times been pumped into the mains. The advice of the Board relative to increasing the supply of water may be found on page 103.

*Norwood.* — The water supply of Norwood is taken from Buckmaster Pond in Westwood. The quantity of water used by the town exceeds the quantity which the source will yield in a series of dry years, and the water has already been drawn to a very low level. Tests were made in 1906 with a view to obtaining an additional supply of water from the ground in the valley of Purgatory Brook. A copy of the advice of the Board relative to the use of ground water obtained in this locality may be found on page 112.

*Oxford.* — Works for the supply of the town of Oxford were constructed by the Oxford Water Company in 1906. The source of supply is a system of tubular wells in the valley of Kidder Brook, between the villages of Oxford and North Oxford. A copy of the advice of the Board relative to obtaining water from the ground at this place may be found on page 114.

*Peabody.* — During the year 1906 works were completed for obtaining water from Suntaug Lake. This lake has an area of 156.5 acres, and a water-shed, including the surface of the lake, of 0.525 of a square mile. Water is pumped from the lake into Spring Pond, one of the original sources of supply of Peabody.

*Provincetown.* — Water for the supply of Provincetown is taken from an open basin constructed near the village. The water drawn from the basin contains an enormous quantity of iron, and during the year 1906 experiments have been made with a view to removing the iron from the water by some process of filtration. The results of the investigations were submitted to the Board and a copy of the advice thereon may be found on page 120.

*Salem and Beverly.* — The sources of supply are Wenham Lake and Longham Brook, water from the latter source being discharged at times into Wenham Lake. The water of Wenham Lake has naturally a low color and is in other respects naturally of good quality. The water of Longham Brook is highly colored and contains a large quantity of organic matter, and it has had an unfavorable effect upon the quality of the water of Wenham Lake. A copy of the advice of the Board relative to enlarging and improving the quality of the water supply may be found on page 123.

*Sharon.* — The sources of supply are a large well and tubular wells situated near Beaver Hole Brook in such a location that the water is affected by the sewage of a portion of the village. The yield of the wells is insufficient for the supply of the town in a dry season and the water of the brook has been used directly at times. Investigations have been

made with a view to obtaining a new supply from tubular wells in the valley of the brook some distance above the present wells and above possible sources of pollution. The advice of the Board relative to proposed sources of additional supply may be found on pages 127, 128 and 129.

*Southbridge.* — During the years 1905 and 1906 a new storage reservoir was constructed on Hatchet Brook above Reservoir No. 3 from which water has formerly been drawn. The new reservoir has an area of 66 acres, a storage capacity of 185,000,000 gallons, and an average depth of 8.6 feet. The water-shed of the reservoir has an area of 2.43 square miles. The soil and organic matter were not removed from the area flooded. During the summer of 1906 the reservoir was partly filled with water, and the quality of the water delivered to the town became very objectionable due to the contact of the water with organic matter. A copy of the advice of the Board in regard to the quality of the water supplied to the town may be found on page 130.

*South Hadley.* (*South Hadley Falls Fire District.*) — The water supply of the South Hadley Falls Fire District is taken from Leaping Well Reservoir and from a small reservoir on Buttery Brook. The water of Leaping Well Reservoir is practically free from pollution, but is subject to tastes and odors from growths of organisms. The water-shed of Buttery Brook contains a large population. A copy of the advice of the Board relative to a proposed plan for preventing the pollution of the water of the brook by this population may be found on page 130.

*Springfield.* — The principal source of supply is Ludlow Reservoir, into which water from several brooks is conveyed by a system of canals. Water is also pumped at times from Chapin, Loon and Five Mile ponds. A copy of the advice of the Board relative to the quality of the water of these ponds may be found on page 135. The water of Ludlow Reservoir contains in summer great numbers of organisms which make the water unfit for domestic purposes. In the early part of the year 1906 works were completed for filtering the water of the reservoir through sand filters. An area of 4 acres was prepared by filling a shallow arm of the reservoir with sand taken from a neighboring knoll. Water is pumped from the reservoir to these filters and collected by a system of underdrains. Plans have been submitted during the year for the approval of the Board of the taking of water from the Westfield Little River. A copy of the advice of the Board relative to the use of this source of supply may be found on pages 132 and 135.

*Wayland.* — The village of Cochituate in the town of Wayland is supplied with water from a shallow storage reservoir on Snake Brook. The water is either drawn from the reservoir directly or from a filter-gallery which is located in part beneath the bottom of the reservoir. The water of the reservoir has a high color and is frequently objectionable

for drinking on account of the disagreeable tastes and odors due to the presence of a large quantity of organic matter. A copy of the advice of the Board with reference to the quality of the water of this source may be found on page 139.

*Westborough.* — The source of supply is Sandra Pond, an artificial storage reservoir. Water from the pond filters through and around a dam into a small basin just below the dam, from which it is drawn for the supply of the town. The water in the pond contains a large quantity of organic matter, and, while the organic matter is largely removed in filtering from the pond to the lower basin, the water in the basin is subject to disagreeable tastes and odors caused by growths of organisms. Plans have been prepared for obtaining a supply of water from the ground in the vicinity of the pond, but the works have not been constructed. A copy of the advice of the Board relative to this scheme may be found on page 140.

***Averages of Chemical Analyses of Surface-water Sources for the Year 1906.***

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Albuminoid. | | | | | | |
| | | | | Free. | Total. | Suspended. | | Nitrates. | Nitrites. | | |
| Metropolitan Water District. | Wachusett Reservoir, upper end. | 0.39 | 3.41 | .0027 | .0162 | .0022 | 0.24 | .0045 | .0001 | 0.48 | 0.7 |
| | Wachusett Reservoir, surface, near dam. | 0.22 | 2.99 | .0024 | .0154 | .0029 | 0.24 | .0021 | .0001 | 0.35 | 0.7 |
| | Wachusett Reservoir, bottom, near dam. | 0.22 | 3.05 | .0030 | .0135 | .0020 | 0.24 | .0030 | .0001 | 0.34 | 0.7 |
| | Wachusett Aqueduct, . | 0.29 | 3.35 | .0037 | .0152 | .0022 | 0.24 | .0015 | .0002 | 0.40 | 0.9 |
| | Sudbury Reservoir, . | 0.21 | 3.32 | .0033 | .0165 | .0035 | 0.28 | .0035 | .0001 | 0.34 | 1.0 |
| | Framingham Reservoir No. 3. | 0.21 | 3.42 | .0024 | .0162 | .0028 | 0.28 | .0035 | .0001 | 0.33 | 1.2 |
| | Hopkinton Reservoir, . | 0.61 | 4.05 | .0030 | .0197 | .0018 | 0.35 | .0033 | .0001 | 0.69 | 0.8 |
| | Ashland Reservoir, . | 0.61 | 3.82 | .0026 | .0217 | .0026 | 0.28 | .0013 | .0000 | 0.73 | 0.8 |
| | Framingham Reservoir No. 2. | 0.70 | 4.10 | .0034 | .0217 | .0022 | 0.32 | .0033 | .0001 | 0.76 | 0.9 |
| | Lake Cochituate, . . | 0.26 | 5.21 | .0030 | .0223 | .0041 | 0.51 | .0013 | .0001 | 0.46 | 1.8 |
| | Chestnut Hill Reservoir. | 0.25 | 3.38 | .0026 | .0162 | .0028 | 0.29 | .0037 | .0001 | 0.35 | 1.1 |
| | Weston Reservoir, . | 0.20 | 3.78 | .0028 | .0147 | .0020 | 0.29 | .0056 | .0003 | 0.30 | 1.1 |
| | Spot Pond, . . . | 0.13 | 3.42 | .0019 | .0170 | .0027 | 0.32 | .0012 | .0000 | 0.27 | 1.2 |
| | Tap in State House, . | 0.24 | 3.90 | .0018 | .0160 | .0025 | 0.35 | .0054 | .0001 | 0.37 | 1.3 |
| | Tap in Revere, . . | 0.11 | 3.84 | .0018 | .0139 | .0014 | 0.32 | .0012 | .0000 | 0.25 | 1.2 |
| | Tap in Quincy, . . | 0.20 | 4.04 | .0015 | .0142 | .0011 | 0.35 | .0030 | .0001 | 0.33 | 1.3 |
| Abington, . . . | Big Sandy Pond, . . | 0.09 | 3.01 | .0025 | .0174 | .0018 | 0.64 | .0010 | .0000 | 0.17 | 0.6 |
| | Little Sandy Pond,[1] . | 0.02 | 3.85 | .0010 | .0213 | .0057 | 1.02 | .0010 | .0000 | 0.23 | 0.2 |

[1] Not used directly.

*Averages of Chemical Analyses of Surface-water Sources, etc.* — Continued.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | | Nitrates. | Nitrites. | | |
| | | | | | Total. | Sus-pended. | | | | | |
| Amherst, . . . | Amethyst Brook Reservoir. | 0.20 | 3.10 | .0027 | .0123 | .0049 | 0.12 | .0030 | .0000 | 0.33 | 0.5 |
| | Lower Reservoir, . | 0.43 | 3.44 | .0025 | .0121 | .0017 | 0.14 | .0020 | .0001 | 0.53 | 0.6 |
| Andover, . . . | Haggett's Pond, . . | 0.17 | 3.57 | .0012 | .0173 | .0016 | 0.31 | .0007 | .0000 | 0.30 | 1.2 |
| Ashburnham, . . | Naukeag Reservoir, . | 0.00 | 3.15 | .0012 | .0049 | .0018 | 0.15 | .0127 | .0001 | 0.05 | 1.0 |
| Ashfield, . . . | Bear Swamp Brook, . | 0.25 | 5.27 | .0030 | .0159 | .0022 | 0.08 | .0025 | .0001 | 0.39 | 2.9 |
| Athol, . . . | Phillipston Reservoir, | 0.59 | 3.27 | .0063 | .0526 | .0209 | 0.13 | .0020 | .0002 | 0.67 | 0.5 |
| | Buckman Brook Reservoir. | 0.34 | 2.97 | .0040 | .0225 | .0038 | 0.12 | .0017 | .0001 | 0.52 | 0.6 |
| Barre, . . . | Reservoir, . . . | 0.19 | 3.16 | .0030 | .0256 | .0055 | 0.16 | .0007 | .0000 | 0.35 | 0.8 |
| Brockton, . . . | Salisbury Brook Reservoir.[1] | 0.54 | 4.19 | .0027 | .0243 | .0039 | 0.43 | .0012 | .0000 | 0.68 | 0.7 |
| | Silver Lake, . . . | 0.11 | 3.36 | .0015 | .0115 | .0013 | 0.61 | .0010 | .0000 | 0.20 | 0.5 |
| Cambridge, . . | Upper Hobbs Brook Reservoir. | 0.54 | 5.47 | .0038 | .0336 | .0088 | 0.39 | .0064 | .0000 | 0.70 | 2.0 |
| | Lower Hobbs Brook Reservoir. | 0.16 | 5.27 | .0030 | .0270 | .0049 | 0.38 | .0012 | .0000 | 0.39 | 2.0 |
| | Stony Brook Reservoir, | 0.40 | 5.35 | .0081 | .0217 | .0026 | 0.43 | .0068 | .0001 | 0.51 | 1.9 |
| | Fresh Pond, . . . | 0.27 | 6.73 | .0086 | .0277 | .0070 | 0.59 | .0146 | .0005 | 0.48 | 2.8 |
| Cheshire, . . . | Thunder Brook, . . | 0.03 | 7.45 | .0020 | .0050 | .0010 | 0.08 | .0095 | .0000 | 0.05 | 4.6 |
| | Kitchen Brook, . . | 0.02 | 5.95 | .0006 | .0033 | .0007 | 0.06 | .0063 | .0000 | 0.04 | 3.9 |
| Chester, . . . | Austin Brook Reservoir. | 0.21 | 2.80 | .0010 | .0089 | .0011 | 0.11 | .0025 | .0000 | 0.23 | 1.1 |
| Chicopee, . . . | Morton Brook, . . | 0.09 | 3.59 | .0013 | .0070 | .0013 | 0.13 | .0035 | .0000 | 0.08 | 0.9 |
| | Cooley Brook, . . | 0.41 | 4.10 | .0015 | .0158 | .0034 | 0.13 | .0040 | .0001 | 0.38 | 1.1 |
| Concord, . . . | Sandy Pond, . . | 0.05 | 2.50 | .0011 | .0131 | .0032 | 0.27 | .0012 | .0000 | 0.18 | 0.4 |
| Dalton, . . . | Egypt Brook Reservoir. | 0.31 | 2.70 | .0025 | .0127 | .0031 | 0.07 | .0190 | .0000 | 0.40 | 0.8 |
| Danvers, . . . | Middleton Pond, . . | 0.61 | 4.14 | .0019 | .0208 | .0022 | 0.36 | .0010 | .0000 | 0.71 | 1.2 |
| Deerfield, . . . | Roaring Brook, . . | 0.11 | 6.13 | .0016 | .0063 | .0006 | 0.19 | .0040 | .0000 | 0.16 | 3.5 |
| Easthampton, . . | Bassett Brook, . . | 0.29 | 3.92 | .0016 | .0113 | .0025 | 0.11 | .0082 | .0000 | 0.34 | 1.2 |
| Fall River, . . | North Watuppa Lake, | 0.24 | 4.00 | .0017 | .0188 | .0034 | 0.58 | .0012 | .0000 | 0.39 | 0.6 |
| Falmouth, . . | Long Pond, . . . | 0.05 | 3.04 | .0010 | .0102 | .0012 | 0.91 | .0005 | .0000 | 0.10 | 0.3 |
| Fitchburg, . . | Meetinghouse Pond, . | 0.08 | 2.74 | .0027 | .0117 | .0008 | 0.14 | .0025 | .0000 | 0.17 | 0.8 |
| | Scott Reservoir, . . | 0.19 | 2.82 | .0054 | .0231 | .0054 | 0.16 | .0012 | .0000 | 0.34 | 0.3 |
| | Wachusett Lake, . . | 0.14 | 2.69 | .0014 | .0148 | .0022 | 0.14 | .0007 | .0000 | 0.22 | 0.4 |
| Gardner, . . . | Crystal Lake, . . | 0.09 | 4.02 | .0022 | .0184 | .0019 | 0.30 | .0032 | .0001 | 0.21 | 1.2 |
| Gloucester, . . | Dike's Brook Reservoir. | 0.52 | 4.16 | .0026 | .0180 | .0022 | 0.95 | .0017 | .0000 | 0.44 | 0.2 |
| | Wallace Reservoir, . | 0.50 | 4.44 | .0018 | .0211 | .0045 | 1.20 | .0010 | .0000 | 0.51 | 0.4 |
| | Haskell Brook Reservoir. | 0.52 | 4.41 | .0121 | .0195 | .0036 | 0.95 | .0020 | .0000 | 0.45 | 0.4 |

[1] Not used.

*Averages of Chemical Analyses of Surface-water Sources, etc.*— Continued.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | | Nitrates. | Nitrites. | | |
| | | | | | Total. | Sus-pended. | | | | | |
| Great Barrington, . | East Mountain Reservoir. | 0.12 | 5.57 | .0097 | .0139 | .0033 | 0.12 | .0010 | .0001 | 0.23 | 3.6 |
| | Green River, . . | 0.03 | 9.62 | .0029 | .0034 | .0004 | 0.09 | .0108 | .0000 | 0.07 | 6.6 |
| Greenfield, . . | Upper reservoir on Glen Brook. | 0.14 | 5.79 | .0028 | .0112 | .0031 | 0.14 | .0055 | .0000 | 0.17 | 3.1 |
| | Lower reservoir on Glen Brook. | 0.11 | 5.77 | .0021 | .0104 | .0023 | 0.13 | .0064 | .0001 | 0.15 | 3.1 |
| Hadley, . . . | Hart's Brook Reservoir. | 0.22 | 4.90 | .0080 | .0126 | .0033 | 0.15 | .0012 | .0000 | 0.27 | 2.1 |
| Hatfield, . . . | Reservoir, . . . | 0.06 | 4.77 | .0009 | .0045 | .0004 | 0.15 | .0152 | .0000 | 0.17 | 1.7 |
| Haverhill, . . | Johnson's Pond, . . | 0.19 | 4.87 | .0020 | .0183 | .0022 | 0.36 | .0010 | .0000 | 0.30 | 1.7 |
| | Crystal Lake, . . | 0.22 | 3.48 | .0019 | .0168 | .0017 | 0.25 | .0017 | .0001 | 0.34 | 0.9 |
| | Kenoza Lake, . . | 0.17 | 4.22 | .0032 | .0177 | .0029 | 0.37 | .0010 | .0001 | 0.34 | 1.7 |
| | Lake Saltonstall, . . | 0.08 | 5.67 | .0036 | .0178 | .0027 | 0.56 | .0013 | .0001 | 0.18 | 1.9 |
| | Millvale Reservoir, . | 0.83 | 4.70 | .0028 | .0242 | .0051 | 0.24 | .0015 | .0000 | 0.84 | 1.3 |
| Hingham, . . | Accord Pond, . . | 0.19 | 3.29 | .0019 | .0135 | .0020 | 0.64 | .0007 | .0000 | 0.31 | 0.2 |
| Holden, . . . | Muschopauge Lake, . | 0.09 | 2.47 | .0027 | .0135 | .0024 | 0.22 | .0010 | .0000 | 0.19 | 0.7 |
| Holyoke, . . . | Whiting Street Reservoir. | 0.14 | 4.61 | .0056 | .0252 | .0069 | 0.14 | .0010 | .0000 | 0.22 | 2.4 |
| | Manhan Brook, . . | 0.35 | 4.51 | .0065 | .0161 | .0036 | 0.12 | .0027 | .0000 | 0.42 | 1.6 |
| | Tucker Brook, . . | 0.35 | 3.66 | .0022 | .0141 | .0023 | 0.11 | .0020 | .0000 | 0.47 | 0.8 |
| | Wright and Ashley Pond. | 0.11 | 5.49 | .0039 | .0223 | .0039 | 0.15 | .0018 | .0001 | 0.23 | 2.7 |
| | High-service Reservoir, | 0.26 | 6.28 | .0030 | .0201 | .0033 | 0.18 | .0041 | .0001 | 0.41 | 2.6 |
| Hudson, . . . | Gates Pond, . . . | 0.15 | 2.45 | .0014 | .0165 | .0033 | 0.21 | .0012 | .0000 | 0.22 | 0.5 |
| Huntington, . . | Cold Brook Reservoir, | 0.18 | 3.13 | .0011 | .0085 | .0009 | 0.11 | .0023 | .0000 | 0.26 | 1.1 |
| Ipswich, . . . | Dow's Brook Reservoir. | 0.24 | 4.80 | .0026 | .0178 | .0030 | 0.64 | .0032 | .0001 | 0.37 | 2.0 |
| Lawrence, . . | Merrimack River, filtered. | 0.37 | 4.94 | .0095 | .0101 | .0006 | 0.33 | .0192 | .0001 | 0.46 | 1.6 |
| | Distributing Reservoir, | 0.34 | 4.81 | .0055 | .0118 | .0012 | 0.33 | .0182 | .0002 | 0.44 | 1.5 |
| Lee, . . . . | Codding Brook, . . | 0.22 | 3.12 | .0016 | .0100 | .0008 | 0.08 | .0030 | .0000 | 0.25 | 1.4 |
| Lenox, . . . | Reservoir, . . . | 0.07 | 7.80 | .0019 | .0134 | .0014 | 0.08 | .0022 | .0000 | 0.16 | 5.8 |
| Leominster, . . | Morse Reservoir, . | 0.19 | 2.42 | .0022 | .0201 | .0034 | 0.16 | .0020 | .0000 | 0.34 | 0.2 |
| | Haynes Reservoir, . | 0.25 | 2.98 | .0032 | .0323 | .0050 | 0.15 | .0007 | .0000 | 0.40 | 0.2 |
| | Fall Brook Reservoir, | 0.15 | 2.78 | .0017 | .0168 | .0028 | 0.15 | .0007 | .0000 | 0.31 | 0.3 |
| Longmeadow, . . | Cooley Brook, . . | 0.08 | 4.95 | .0013 | .0045 | .0011 | 0.18 | .0237 | .0002 | 0.06 | 2.5 |
| Lynn, . . . | Birch Reservoir, . . | 0.37 | 4.03 | .0034 | .0259 | .0045 | 0.57 | .0026 | .0001 | 0.48 | 1.3 |
| | Breed's Reservoir, . | 0.46 | 4.24 | .0040 | .0246 | .0045 | 0.57 | .0012 | .0000 | 0.53 | 0.9 |
| | Walden Reservoir, . | 0.45 | 5.05 | .0041 | .0274 | .0049 | 0.64 | .0018 | .0001 | 0.60 | 1.6 |
| | Hawkes Reservoir, . | 0.47 | 5.19 | .0035 | .0248 | .0036 | 0.63 | .0012 | .0000 | 0.61 | 1.9 |

*Averages of Chemical Analyses of Surface-water Sources, etc.* — Continued.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Albuminoid. | | | | | | |
| | | | | Free. | Total. | Sus-pended. | | Nitrates. | Nitrites. | | |
| Lynn, | Saugus River, | 0.83 | 8.10 | .0056 | .0327 | .0034 | 0.78 | .0020 | .0002 | 0.95 | 3.2 |
| Marlborough, | Lake Williams, | 0.12 | 4.23 | .0029 | .0207 | .0032 | 0.48 | .0012 | .0000 | 0.25 | 1.8 |
| | Millham Brook Reservoir. | 0.53 | 4.54 | .0067 | .0237 | .0051 | 0.34 | .0056 | .0001 | 0.52 | 1.1 |
| Maynard, | White Pond, | 0.23 | 3.41 | .0011 | .0118 | .0006 | 0.28 | .0047 | .0000 | 0.32 | 0.9 |
| Milford, | Charles River, filtered, | 0.22 | 3.76 | .0013 | .0084 | – | 0.31 | .0208 | .0000 | 0.26 | 1.2 |
| Montague, | Lake Pleasant, | 0.06 | 2.19 | .0027 | .0094 | .0013 | 0.12 | .0020 | .0000 | 0.12 | 0.4 |
| Nantucket, | Wannacomet Pond, | 0.04 | 5.90 | .0017 | .0116 | .0026 | 2.08 | .0062 | .0000 | 0.10 | 1.1 |
| New Bedford, | Little Quittacas Pond, | 0.33 | 3.64 | .0021 | .0181 | .0022 | 0.52 | .0007 | .0000 | 0.46 | 0.5 |
| | Great Quittacas Pond, | 0.49 | 3.50 | .0023 | .0188 | .0020 | 0.53 | .0010 | .0000 | 0.67 | 0.5 |
| North Adams, | Notch Brook Reservoir, | 0.06 | 7.02 | .0043 | .0065 | .0016 | 0.08 | .0017 | .0011 | 0.13 | 4.7 |
| | Broad Brook, | 0.22 | 3.77 | .0054 | .0090 | .0009 | 0.08 | .0190 | .0000 | 0.32 | 1.8 |
| Northampton, | Middle Reservoir, | 0.35 | 4.41 | .0026 | .0168 | .0027 | 0.12 | .0024 | .0001 | 0.43 | 1.5 |
| | Mountain Street Reservoir. | 0.08 | 3.89 | .0011 | .0115 | .0029 | 0.10 | .0017 | .0000 | 0.18 | 1.7 |
| North Andover, | Great Pond, | 0.15 | 3.79 | .0022 | .0186 | .0025 | 0.35 | .0010 | .0000 | 0.31 | 1.8 |
| Northborough, | Lower Reservoir, | 0.81 | 4.31 | .0042 | .0252 | .0041 | 0.23 | .0030 | .0000 | 0.79 | 0.8 |
| Northbridge, | Cook Allen Reservoir, | 0.29 | 3.10 | .0037 | .0272 | .0061 | 0.16 | .0010 | .0000 | 0.41 | 0.2 |
| North Brookfield, | Doane Pond, | 0.58 | 3.74 | .0063 | .0283 | .0064 | 0.16 | .0027 | .0001 | 0.54 | 0.6 |
| | North Pond,[1] | 0.56 | 3.51 | .0061 | .0278 | .0062 | 0.15 | .0040 | .0000 | 0.61 | 0.6 |
| Northfield, | Reservoir, | 0.65 | 3.75 | .0024 | .0276 | .0062 | 0.11 | .0000 | .0000 | 0.75 | 0.8 |
| Norwood, | Buckmaster Pond, | 0.14 | 4.15 | .0064 | .0197 | .0042 | 0.48 | .0018 | .0001 | 0.22 | 1.1 |
| Palmer, | Lower Reservoir, | 0.29 | 3.25 | .0017 | .0165 | .0019 | 0.12 | .0020 | .0000 | 0.27 | 0.6 |
| Peabody, | Brown's Pond, | 0.18 | 4.02 | .0018 | .0154 | .0026 | 0.63 | .0085 | .0000 | 0.28 | 0.7 |
| | Spring Pond, | 0.02 | 8.94 | .0172 | .0081 | .0012 | 0.64 | .0062 | .0001 | 0.10 | 3.1 |
| | Reservoir, | 0.06 | 6.27 | .0026 | .0108 | .0011 | 0.74 | .0522 | .0004 | 0.13 | 2.1 |
| | Suntaug Lake, | 0.06 | 4.22 | .0023 | .0164 | .0028 | 0.67 | .0010 | .0000 | 0.15 | 1.7 |
| Plymouth, | Little South Pond, | 0.02 | 2.46 | .0013 | .0154 | .0020 | 0.67 | .0007 | .0000 | 0.12 | 0.1 |
| Randolph, | Great Pond, | 0.48 | 4.50 | .0024 | .0205 | .0019 | 0.66 | .0042 | .0001 | 0.63 | 1.1 |
| Rockport, | Cape Pond, | 0.30 | 8.76 | .0103 | .0299 | .0075 | 2.93 | .0017 | .0001 | 0.29 | 1.6 |
| Salem, | Wenham Lake, | 0.28 | 6.02 | .0049 | .0230 | .0046 | 0.85 | .0042 | .0002 | 0.43 | 2.0 |
| | Longham Reservoir, | 1.34 | 7.01 | .0117 | .0381 | .0067 | 0.93 | .0052 | .0001 | 1.23 | 1.6 |
| Southbridge, | Hatchet Brook Reservoir. | 0.52 | 3.66 | .0065 | .0213 | .0022 | 0.16 | .0015 | .0000 | 0.58 | 0.8 |
| South Hadley, | Leaping Well Reservoir. | 0.12 | 2.90 | .0063 | .0228 | .0099 | 0.13 | .0037 | .0001 | 0.13 | 0.7 |
| | Buttery Brook Reservoir. | 0.26 | 3.74 | .0085 | .0150 | .0042 | 0.22 | .0237 | .0004 | 0.26 | 0.7 |

[1] Not used.

*Averages of Chemical Analyses of Surface-water Sources, etc.* — Continued.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. Sus-pended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Spencer, | Shaw Pond, | 0.07 | 3.14 | .0022 | .0147 | .0010 | 0.19 | .0042 | .0000 | 0.14 | 1.1 |
| Springfield, | Jabish Canal, | 0.42 | 3.71 | .0021 | .0186 | .0018 | 0.13 | .0029 | .0001 | 0.48 | 0.8 |
| | Axe Factory Brook, | 0.43 | 4.10 | .0019 | .0157 | .0020 | 0.17 | .0032 | .0000 | 0.55 | 1.2 |
| | Higher Brook, | 0.50 | 3.23 | .0017 | .0141 | .0014 | 0.11 | .0007 | .0000 | 0.61 | 0.6 |
| | Broad Brook Canal, | 0.74 | 4.78 | .0027 | .0187 | .0023 | 0.15 | .0044 | .0000 | 0.77 | 1.2 |
| | Ludlow Basin, | 0.26 | 3.35 | .0012 | .0185 | .0026 | 0.14 | .0010 | .0000 | 0.34 | 1.0 |
| | Ludlow Canal, | 0.53 | 3.94 | .0021 | .0168 | .0022 | 0.17 | .0037 | .0001 | 0.58 | 1.0 |
| | Ludlow Reservoir, | 0.28 | 3.07 | .0023 | .0189 | .0040 | 0.14 | .0017 | .0001 | 0.36 | 0.7 |
| | Chapin Pond, | 0.07 | 2.30 | .0026 | .0175 | .0038 | 0.11 | .0022 | .0000 | 0.19 | 0.4 |
| | Five Mile Pond, | 0.10 | 2.80 | .0069 | .0175 | .0020 | 0.15 | .0031 | .0001 | 0.20 | 0.5 |
| | Loon Pond, | 0.04 | 2.84 | .0021 | .0175 | .0019 | 0.24 | .0028 | .0000 | 0.14 | 0.6 |
| | Westfield Little River, | 0.46 | 3.19 | .0018 | .0198 | .0067 | 0.11 | .0037 | .0001 | 0.56 | 0.7 |
| Stockbridge, | Lake Averic, | 0.10 | 5.84 | .0034 | .0213 | .0056 | 0.07 | .0025 | .0000 | 0.26 | 3.4 |
| Taunton, | Assawompsett Pond, | 0.36 | 3.54 | .0029 | .0186 | .0028 | 0.50 | .0010 | .0000 | 0.53 | 0.5 |
| | Elder's Pond, | 0.12 | 3.37 | .0021 | .0173 | .0021 | 0.50 | .0007 | .0000 | 0.30 | 0.5 |
| | Long Pond, | 0.84 | 3.75 | .0028 | .0225 | .0063 | 0.49 | .0012 | .0000 | 0.96 | 0.6 |
| Wakefield, | Crystal Lake, | 0.19 | 4.78 | .0044 | .0208 | .0039 | 0.61 | .0050 | .0000 | 0.29 | 1.8 |
| Wareham, | Jonathan's Pond, | 0.02 | 2.52 | .0012 | .0099 | .0018 | 0.65 | .0005 | .0000 | 0.09 | 0.0 |
| Wayland, | Snake Brook Reservoir, | 0.95 | 4.50 | .0039 | .0298 | .0060 | 0.27 | .0015 | .0000 | 0.89 | 1.3 |
| Westborough, | Upper Sandra Pond, | 0.28 | 3.09 | .0024 | .0217 | .0047 | 0.21 | .0004 | .0000 | 0.40 | 0.5 |
| | Lower Sandra Pond, | 0.05 | 3.48 | .0023 | .0097 | .0015 | 0.22 | .0012 | .0000 | 0.18 | 1.0 |
| Westfield, | Montgomery Reservoir, | 0.39 | 2.83 | .0049 | .0209 | .0042 | 0.13 | .0017 | .0000 | 0.54 | 0.4 |
| | Tillotson Brook, | 0.14 | 2.89 | .0017 | .0079 | .0008 | 0.15 | .0025 | .0001 | 0.18 | 0.5 |
| | Tekoa Reservoir, | 0.40 | 3.09 | .0020 | .0157 | .0013 | 0.13 | .0020 | .0001 | 0.54 | 0.4 |
| West Springfield, | Darby Brook Reservoir. | 0.25 | 5.20 | .0027 | .0157 | .0047 | 0.20 | .0040 | .0002 | 0.30 | 2.2 |
| Weymouth, | Great Pond, | 0.78 | 4.46 | .0042 | .0205 | .0024 | 0.58 | .0015 | .0000 | 0.74 | 0.5 |
| Williamsburg, | Reservoir, | 0.28 | 3.95 | .0046 | .0119 | .0021 | 0.11 | .0018 | .0000 | 0.34 | 1.6 |
| Winchester, | North Reservoir, | 0.08 | 3.90 | .0026 | .0199 | .0036 | 0.43 | .0012 | .0000 | 0.21 | 1.5 |
| | South Reservoir, | 0.22 | 3.31 | .0094 | .0177 | .0015 | 0.35 | .0020 | .0001 | 0.24 | 1.1 |
| | Middle Reservoir, | 0.17 | 3.55 | .0084 | .0279 | .0060 | 0.37 | .0015 | .0001 | 0.34 | 1.1 |
| Woburn, | Horn Pond,[1] | 0.29 | 7.22 | .0068 | .0296 | .0093 | 0.93 | .0295 | .0009 | 0.46 | 2.9 |
| Worcester, | Bottomly Reservoir, | 0.35 | 4.34 | .0035 | .0228 | .0082 | 0.24 | .0150 | .0001 | 0.55 | 1.4 |
| | Kent Reservoir, | 0.19 | 3.59 | .0025 | .0165 | .0020 | 0.20 | .0055 | .0000 | 0.33 | 0.9 |

[1] Not used.

*Averages of Chemical Analyses of Surface-water Sources, etc.* — Concluded.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. Suspended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Worcester, . . | Leicester Reservoir, . | 0.22 | 3.14 | .0045 | .0153 | .0016 | 0.19 | .0037 | .0001 | 0.34 | 0.8 |
| | Upper Holden Reservoir. | 0.19 | 2.87 | .0026 | .0142 | .0021 | 0.18 | .0025 | .0000 | 0.28 | 0.5 |
| | Lower Holden Reservoir. | 0.12 | 2.47 | .0026 | .0130 | .0020 | 0.18 | .0018 | .0000 | 0.19 | 0.6 |

*Averages of Chemical Analyses of Ground-water Sources for the Year 1906.*

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. Free. | Ammonia. Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Hardness. | Iron. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams, . . . | Tubular wells, . . . . | .00 | 15.72 | .0005 | .0013 | 0.11 | .0380 | .0000 | .04 | 11.6 | .0040 |
| Amesbury, . . | Main Street wells, . . | .16 | 10.87 | .0013 | .0018 | 0.73 | .0565 | .0001 | .03 | 4.6 | .1420 |
| | Market Street wells, . . | .04 | 24.62 | .0031 | .0037 | 1.24 | .0192 | .0003 | .03 | 12.0 | .0167 |
| Attleborough, . | Old well, . . . . . | .01 | 4.60 | .0008 | .0039 | 0.39 | .0065 | .0000 | .04 | 1.9 | .0062 |
| | New well, . . . . . | .02 | 4.83 | .0008 | .0053 | 0.41 | .0097 | .0000 | .04 | 2.0 | .0092 |
| Avon, . . . . | Well, . . . . . . | .00 | 3.63 | .0009 | .0021 | 0.47 | .0420 | .0000 | .02 | 1.2 | .0047 |
| Ayer, . . . . | Well, . . . . . . | .00 | 5.17 | .0006 | .0022 | 0.50 | .0195 | .0000 | .01 | 2.0 | .0087 |
| Billerica, . . | Tubular wells, . . . . | .16 | 7.37 | .0020 | .0045 | 0.27 | .0042 | .0000 | .15 | 2.2 | .0463 |
| Braintree, . . | Filter gallery, . . . . | .04 | 6.07 | .0028 | .0062 | 1.02 | .0460 | .0001 | .10 | 1.9 | .0095 |
| Bridgewater, . | Wells, . . . . . . | .15 | 7.57 | .0009 | .0081 | 0.42 | .0087 | .0000 | .07 | 2.6 | .1552 |
| Brookline, . . | Tubular wells and filter gallery. | .13 | 9.10 | .0046 | .0064 | 0.59 | .0248 | .0001 | .15 | 4.1 | .0218 |
| Canton, . . . | Springdale well, . . . | .03 | 4.25 | .0011 | .0027 | 0.38 | .0080 | .0000 | .04 | 1.2 | .0142 |
| | Well near Henry's Spring, | .13 | 4.55 | .0010 | .0041 | 0.42 | .0170 | .0000 | .16 | 1.4 | .0067 |
| Cohasset, . . | Tubular wells No. 1, . . | .03 | 14.40 | .0010 | .0020 | 1.73 | .0200 | .0000 | .01 | 6.3 | .0130 |
| | Tubular wells No. 2, . . | .00 | 11.30 | .0005 | .0019 | 1.44 | .0637 | .0000 | .04 | 3.8 | .0083 |
| | Filter gallery, . . . | .37 | 11.95 | .2160 | .0165 | 1.24 | .0015 | .0005 | .53 | 5.0 | .0270 |
| Cottage City, . | Springs, . . . . . | .01 | 3.77 | .0010 | .0012 | 0.90 | .0073 | .0000 | .00 | 0.4 | .0270 |
| Dedham, . . | Tap in pumping station, . | .01 | 10.30 | .0016 | .0037 | 0.87 | .1623 | .0002 | .04 | 3.5 | .0083 |
| Dracut (Collinsville), | Tubular wells, . . . . | .01 | 5.70 | .0004 | .0020 | 0.26 | .0238 | .0000 | .02 | 1.9 | .0088 |
| Easton, . . . | Well, . . . . . . | .01 | 4.62 | .0004 | .0024 | 0.62 | .0552 | .0000 | .01 | 1.7 | .0142 |
| Fairhaven, . . | Tubular wells, . . . . | .52 | 6.80 | .0021 | .0104 | 1.03 | .0512 | .0001 | .67 | 2.2 | .0203 |

*Averages of Chemical Analyses of Ground-water Sources, etc.* — Continued.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. | Iron. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | | |
| Foxborough, | Tubular wells, | .00 | 3.75 | .0005 | .0014 | 0.35 | .0308 | .0000 | .02 | 0.8 | .0067 |
| Framingham, | Filter gallery, | .06 | 8.68 | .0038 | .0117 | 0.91 | .0232 | .0003 | .15 | 3.8 | .0185 |
| Grafton, | Tap in town, | .12 | 12.90 | .0005 | .0057 | 1.68 | .2700 | .0001 | .10 | 4.2 | .0507 |
| Groton, | Well, | .00 | 4.85 | .0008 | .0017 | 0.17 | .0077 | .0000 | .00 | 1.9 | .0060 |
| Hingham, | Wells, | .03 | 5.90 | .0009 | .0054 | 0.72 | .0153 | .0000 | .07 | 1.6 | .0092 |
| Hopkinton, | Tubular wells, | .00 | 11.67 | .0005 | .0023 | 1.03 | .3300 | .0000 | .01 | 4.2 | .0203 |
| Hyde Park, | Tubular wells near Neponset River. | .14 | 12.47 | .0141 | .0057 | 1.83 | .0783 | .0003 | .11 | 4.6 | .0859 |
| | Tubular wells near Mother Brook. | .17 | 8.86 | .0013 | .0088 | 0.94 | .1200 | .0000 | .27 | 2.8 | .0134 |
| Kingston, | Tubular wells, | .00 | 4.85 | .0008 | .0020 | 0.75 | .0092 | .0000 | .02 | 1.0 | .0080 |
| Leicester, | Wells, | .85 | 6.70 | .0018 | .0178 | 0.15 | .0650 | .0000 | .86 | 2.1 | .0130 |
| Lowell, | Boulevard wells (tubular), | .09 | 4.71 | .0058 | .0051 | 0.25 | .0088 | .0000 | .10 | 1.6 | .0439 |
| | Low-service Reservoir, | .08 | 5.00 | .0033 | .0075 | 0.27 | .0181 | .0002 | .13 | 1.7 | .0297 |
| Manchester, | Large well, | .00 | 11.20 | .0007 | .0015 | 1.76 | .1300 | .0000 | .01 | 3.1 | .0115 |
| Mansfield, | Well, | .00 | 2.92 | .0003 | .0011 | 0.34 | .0115 | .0000 | .00 | 0.7 | .0065 |
| Marblehead, | Well No. 1, | .18 | 21.73 | .0143 | .0030 | 3.78 | .0227 | .0003 | .05 | 6.3 | .2963 |
| | Well No. 2, | .18 | 22.02 | .0202 | .0031 | 3.85 | .0187 | .0001 | .07 | 6.6 | .4675 |
| Marshfield, | Well, | .01 | 12.20 | .0004 | .0018 | 3.29 | .0820 | .0000 | .00 | 2.3 | .0050 |
| Medfield, | Spring, | .01 | 3.50 | .0012 | .0044 | 0.27 | .0160 | .0000 | .14 | 1.6 | .0080 |
| Merrimac, | Tubular wells, | .04 | 5.04 | .0008 | .0011 | 0.48 | .0418 | .0000 | .01 | 1.9 | .0154 |
| Methuen, | Tubular wells, | .16 | 7.23 | .0021 | .0064 | 0.34 | .0177 | .0000 | .17 | 3.2 | .0365 |
| Middleborough, | Well, | .22 | 6.62 | .0031 | .0058 | 0.62 | .0588 | .0001 | .14 | 2.2 | .1126 |
| Millbury, | Well, | .00 | 5.24 | .0004 | .0022 | 0.34 | .0226 | .0000 | .01 | 1.8 | .0044 |
| Millis, | Spring, | .00 | 8.40 | .0002 | .0010 | 0.68 | .1600 | .0000 | .00 | 3.4 | .0010 |
| Monson, | Well, | .00 | 3.50 | .0008 | .0019 | 0.12 | .0103 | .0000 | .00 | 1.0 | .0033 |
| Nantucket, | Wells, | .13 | 7.27 | .0353 | .0078 | 2.13 | .0107 | .0012 | .12 | 2.1 | .1252 |
| Natick, | Well, | .00 | 8.52 | .0007 | .0024 | 0.54 | .0362 | .0000 | .01 | 3.9 | .0032 |
| Needham, | Well No. 1, | .00 | 5.67 | .0006 | .0020 | 0.61 | .0942 | .0000 | .02 | 1.8 | .0047 |
| | Well No. 2, | .00 | 5.98 | .0004 | .0020 | 0.71 | .1435 | .0000 | .02 | 2.1 | .0049 |
| | Hicks Spring,[1] | .01 | 4.90 | .0003 | .0015 | 0.48 | .0646 | .0000 | .01 | 1.4 | .0057 |
| Newburyport, | Tap in pumping station, | .22 | 8.76 | .0012 | .0068 | 0.69 | .0056 | .0000 | .07 | 3.4 | .0720 |
| | Tubular wells, | .24 | 10.50 | .0012 | .0074 | 1.14 | .0034 | .0000 | .08 | 3.9 | .0962 |
| Newton, | Tubular wells and filter gallery. | .10 | 6.42 | .0009 | .0063 | 0.43 | .0362 | .0000 | .15 | 2.5 | .0080 |
| No. Attleborough, | Old well, | .01 | 6.60 | .0008 | .0027 | 0.65 | .0507 | .0000 | .01 | 3.0 | .0115 |
| | New well, | .00 | 5.10 | .0008 | .0018 | 0.36 | .0070 | .0000 | .01 | 2.6 | .0170 |

[1] Not used.

*Averages of Chemical Analyses of Ground-water Sources, etc.* — Concluded.

[Parts in 100,000.]

| City or Town. | Source. | Color. | Residue on Evaporation. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. | Iron. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | | |
| Provincetown, | Well, | – | 12.14 | .0166 | .0165 | 2.86 | .0016 | .0000 | .79 | 3.3 | .6787 |
| Reading, | Filter gallery, | .53 | 8.26 | .0105 | .0116 | 0.58 | .0039 | .0000 | .54 | 2.6 | .2560 |
| | Filtered water, | .17 | 13.42 | .0071 | .0064 | 0.59 | .0034 | .0003 | .24 | 7.2 | .0248 |
| Scituate, | Wells, | .00 | 16.05 | .0008 | .0018 | 3.55 | .2165 | .0000 | .06 | 2.8 | .0115 |
| Sharon, | Well, | .01 | 11.75 | .0014 | .0033 | 1.19 | .2500 | .0000 | .01 | 3.3 | .0117 |
| Sheffield, | Spring, | .23 | 4.40 | .0006 | .0082 | 0.11 | .0060 | .0001 | .30 | 2.0 | .0160 |
| Shirley, | Well, | .00 | 2.45 | .0010 | .0010 | 0.13 | .0060 | .0000 | .00 | 0.4 | .0187 |
| Stoughton, | Tap at pumping station, | .34 | 3.33 | .0010 | .0105 | 0.36 | .0060 | .0000 | .39 | 0.7 | .0158 |
| Tisbury, | Well, | .00 | 4.67 | .0006 | .0017 | 1.05 | .0017 | .0000 | .00 | 0.5 | .0085 |
| Uxbridge, | Wells, | .02 | 4.22 | .0012 | .0016 | 0.37 | .0679 | .0000 | .02 | 1.1 | .0244 |
| Walpole, | Tubular wells, | .02 | 4.24 | .0006 | .0014 | 0.37 | .0284 | .0000 | .01 | 1.4 | .0068 |
| Waltham, | Well, | .11 | 7.88 | .0034 | .0038 | 0.67 | .0298 | .0000 | .06 | 3.2 | .0439 |
| Ware, | Well, | .01 | 6.50 | .0005 | .0016 | 0.43 | .1733 | .0000 | .01 | 2.2 | .0090 |
| Webster, | Well, | .04 | 3.65 | .0012 | .0039 | 0.24 | .0205 | .0000 | .05 | 1.2 | .0160 |
| Wellesley, | Tubular wells, | .08 | 9.21 | .0008 | .0019 | 0.83 | .1636 | .0000 | .02 | 3.6 | .0072 |
| | Well at Williams Spring, | .00 | 10.67 | .0009 | .0019 | 0.97 | .3050 | .0000 | .02 | 3.5 | .0077 |
| Weston, | Well, | .11 | 7.75 | .0005 | .0058 | 0.47 | .0300 | .0000 | .17 | 3.0 | .0100 |
| Winchendon, | Well, | .06 | 3.35 | .0013 | .0023 | 0.11 | .0026 | .0000 | .06 | 0.7 | .0627 |
| Woburn, | Filter gallery, | .01 | 10.44 | .0076 | .0044 | 1.17 | .0142 | .0000 | .07 | 4.5 | .0085 |

# EXAMINATION OF RIVERS.

# EXAMINATION OF RIVERS.

In the report for the year 1902, in the chapter entitled "Report upon the Examinations of the Outlets of Sewers and the Effect of Sewage Disposal in Massachusetts," the results of the investigation made in that year of the sources of pollution of streams in the State are presented in much detail, together with the results of analyses of the waters of these streams for a long series of years.

During the year 1906 the condition of the streams has not changed materially, and the examinations have been confined to a few of the more important rivers.

Chemical analyses of samples of water from the following streams have been made at frequent intervals during the year: —

| | | |
|---|---|---|
| Assabet. | Merrimack. | Sudbury. |
| Blackstone. | Millers. | Taunton. |
| Charles. | Nashua. | Ten Mile. |
| Connecticut. | Neponset. | Westfield. |
| French. | Quinepoxet. | Westfield Little. |
| Hoosick. | Saugus. | |
| Ipswich. | Stillwater. | |

A summary of the various analyses showing the condition of the Blackstone and Merrimack rivers at several points is appended.

## Blackstone River.

### Chemical Examination of Water from Blackstone River. — Averages for Six Months, from June to November, 1887 to 1906, inclusive.

*Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.*

[Parts in 100,000.]

| Months. | Color. | Residue on Evaporation. | | Free Ammonia. | Albuminoid Ammonia. | | | Chlorine. | Nitrogen as | | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total. | Loss on Ignition. | | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | |
| June-Nov., 1887, | 0.91 | - | - | .2686 | .1741 | - | - | 1.35 | .0160 | - | - |
| " " 1888, | 0.76 | - | - | .2658 | .1112 | .0557 | .0555 | 1.50 | .0382 | .0041 | - |
| " " 1889, | 0.86 | - | - | .3980 | .1430 | .0772 | .0658 | 1.32 | .0177 | .0026 | - |
| " " 1890, | 1.14 | 9.92 | 3.03 | .2107 | .1246 | .0678 | .0578 | 1.07 | .0250 | .0015 | 2.9 |
| " " 1891, | 1.10 | 17.42 | 5.59 | .4913 | .1950 | .1127 | .0823 | 2.29 | .0192 | .0037 | 5.0 |
| " " 1892, | 0.52 | 20.75 | 6.30 | .3547 | .1433 | .0708 | .0725 | 2.43 | .0227 | .0108 | 6.1 |
| " " 1893, | 0.40 | 16.93 | 4.55 | .1480 | .0588 | .0240 | .0348 | 1.01 | .0115 | .0015 | 6.3 |
| " " 1894, | 0.66 | 16.93 | 4.76 | .0548 | .0380 | .0236 | .0144 | 0.74 | .0115 | .0005 | 4.4 |
| " " 1895, | 0.49 | 14.17 | 4.50 | .0613 | .0414 | .0243 | .0171 | 0.92 | .0163 | .0006 | 3.4 |
| " " 1896, | 0.51 | 12.90 | 2.93 | .0780 | .0415 | .0232 | .0183 | 0.97 | .0147 | .0015 | 3.4 |
| " " 1897, | 0.85 | 26.45 | 7.68 | .1130 | .0674 | .0362 | .0312 | 0.89 | .0090 | .0024 | 4.2 |
| " " 1898, | 0.33 | 17.42 | 5.62 | .0857 | .0619 | .0260 | .0359 | 0.96 | .0053 | .0010 | 4.6 |
| " " 1899, | 0.14 | 34.38 | 10.60 | .2583 | .0788 | .0390 | .0398 | - | - | .0004 | 14.3 |
| " " 1900, | 0.05 | 16.48 | 3.38 | .1068 | .0518 | .0210 | .0308 | 1.08 | .0107 | .0012 | 3.6 |
| " " 1901, | 0.23 | 31.03 | 11.68 | .1410 | .0548 | .0309 | .0239 | - | - | .0023 | 13.8 |
| " " 1902, | 0.10 | 46.15 | 12.47 | .2453 | .0728 | .0274 | .0454 | - | - | .0010 | 16.5 |
| " " 1903, | 0.18 | 24.06 | 6.80 | .2336 | .0750 | .0472 | .0278 | - | - | .0027 | 8.4 |
| " " 1904, | 0.12 | 44.68 | 17.08 | .1228 | .0434 | .0225 | .0209 | - | - | .0006 | 14.7 |
| " " 1905, | 0.21 | 50.36 | 19.49 | .0952 | .0492 | .0203 | .0289 | - | - | .0003 | 29.3 |
| " " 1906, | 0.11 | 40.07 | 15.25 | .0688 | .0421 | .0189 | .0232 | - | .0032 | .0002 | 20.3 |

*Blackstone River, below Sewage Precipitation Works.*

| Months. | Color. | Residue on Evaporation: Total. | Residue on Evaporation: Loss on Ignition. | Free Ammonia. | Albuminoid Ammonia: Total. | Albuminoid Ammonia: Dissolved. | Albuminoid Ammonia: Suspended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| June-Nov., 1887, | 0.91 | - | - | .2686 | .1741 | - | - | 1.35 | .0160 | - | - |
| " " 1888, | 0.76 | - | - | .2658 | .1112 | .0557 | .0555 | 1.50 | .0382 | .0041 | - |
| " " 1889, | 0.86 | - | - | .3980 | .1430 | .0772 | .0658 | 1.32 | .0177 | .0026 | - |
| " " 1890, | 0.97 | 11.36 | 3.10 | .2907 | .1492 | .0722 | .0770 | 1.46 | .0270 | .0018 | 3.9 |
| " " 1891, | 1.05 | 22.25 | 6.60 | .6367 | .1508 | .0883 | .0625 | 2.61 | .0233 | .0040 | 6.2 |
| " " 1892, | 0.63 | 26.80 | 7.75 | .5240 | .1810 | .0958 | .0652 | 3.13 | .0137 | .0050 | 10.3 |
| " " 1893, | 0.51 | 30.00 | 7.13 | .5680 | .1453 | .0900 | .0553 | 2.76 | .0285 | .0126 | 10.9 |
| " " 1894, | 0.40 | 29.30 | 5.86 | .6189 | .1390 | .1113 | .0277 | 2.63 | .0212 | .0071 | 10.6 |
| " " 1895, | 0.71 | 22.15 | 5.18 | .3246 | .0898 | .0597 | .0301 | 1.86 | .0267 | .0063 | 7.3 |
| " " 1896, | 0.30 | 26.03 | 6.53 | .2831 | .0898 | .0600 | .0298 | 2.10 | .0217 | .0118 | 9.7 |
| " " 1897, | 0.73 | 25.98 | 4.97 | .3650 | .1122 | .0782 | .0340 | 1.61 | .0207 | .0063 | 6.9 |
| " " 1898, | 0.23 | 25.63 | 6.73 | .3064 | .0868 | .0560 | .0308 | 1.55 | .0132 | .0119 | 9.2 |
| " " 1899, | 0.14 | 44.02 | 9.67 | .5251 | .1707 | .0912 | .0795 | 3.26 | .0108 | .0068 | 16.1 |
| " " 1900, | 0.22 | 24.57 | 4.48 | .4430 | .1249 | .0621 | .0628 | 2.13 | .0110 | .0145 | 7.3 |
| " " 1901, | 0.09 | 31.12 | 6.90 | .4580 | .1298 | .0772 | .0521 | 3.42 | .0090 | .0058 | 10.8 |
| " " 1902, | 0.15 | 49.62 | 13.38 | .7296 | .1284 | .0736 | .0548 | 2.97 | - | .0033 | 12.5 |
| " " 1903, | 0.39 | 31.08 | 9.48 | .3880 | .1060 | .0545 | .0535 | - | - | .0062 | 10.4 |
| " " 1904, | - | 50.25 | 13.73 | .6381 | .1523 | .0601 | .0922 | - | - | .0027 | 16.9 |
| " " 1905, | 0.19 | 59.84 | 17.97 | .4936 | .0965 | .0597 | .0888 | - | - | .0006 | 29.3 |
| " " 1906, | 0.19 | 49.69 | 11.42 | .6330 | .1818 | .0580 | .1238 | - | .0058 | .0130 | 15.0 |

**BLACKSTONE RIVER.**

## CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Concluded.*

### *Blackstone River, at Uxbridge.*

[Parts in 100,000.]

| Months. | Color. | Residue on Evaporation. | | Free Ammonia. | Albuminoid Ammonia. | | | Chlorine. | Nitrogen as | | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total. | Loss on Ignition. | | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | |
| June-Nov., 1887, | .39 | - | - | .1129 | .0271 | - | - | 0.79 | .0360 | - | - |
| " " 1888, | .38 | 6.42 | 1.52 | .1155 | .0288 | .0222 | .0066 | 0.68 | .0310 | .0007 | - |
| " " 1889, | .32 | - | - | .1133 | .0296 | .0192 | .0104 | 0.66 | .0333 | .0009 | - |
| " " 1890, | .28 | 8.86 | 2.12 | .1629 | .0231 | .0174 | .0057 | 0.79 | .0259 | .0006 | 2.9 |
| " " 1891, | .20 | 10.16 | 2.61 | .2280 | .0175 | .0117 | .0058 | 1.04 | .0425 | .0007 | 3.6 |
| " " 1892, | .13 | 9.36 | 1.88 | .2840 | .0227 | .0162 | .0065 | 0.99 | .0313 | .0007 | 3.1 |
| " " 1893, | .24 | 11.74 | 2.37 | .1985 | .0207 | .0140 | .0067 | 1.20 | .0623 | .0050 | 4.2 |
| " " 1894, | .35 | 13.07 | 2.03 | .1456 | .0243 | .0183 | .0060 | 1.57 | .0673 | .0050 | 4.9 |
| " " 1895, | .56 | 12.95 | 2.69 | .0906 | .0258 | .0182 | .0076 | 1.34 | .0631 | .0065 | 4.7 |
| " " 1896, | .33 | 12.68 | 2.67 | .1129 | .0257 | .0221 | .0036 | 1.38 | .0477 | .0091 | 5.0 |
| " " 1897, | .48 | 11.60 | 2.47 | .1029 | .0280 | .0215 | .0065 | 1.32 | .0652 | .0051 | 4.8 |
| " " 1898, | .49 | 10.59 | 2.78 | .0801 | .0264 | .0219 | .0045 | 1.00 | .0470 | .0076 | 3.8 |
| " " 1899, | .18 | 18.34 | 3.11 | .2490 | .0359 | .0310 | .0049 | 2.17 | .0510 | .0141 | 7.4 |
| " " 1900, | .19 | 13.42 | 2.04 | .2260 | .0347 | .0257 | .0090 | 1.76 | .0558 | .0060 | 5.0 |
| " " 1901, | .22 | 13.91 | 2.67 | .3159 | .0285 | .0240 | .0045 | 1.50 | .0195 | .0035 | 5.0 |
| " " 1902, | .15 | 14.17 | 2.56 | .3462 | .0270 | .0218 | .0052 | 1.95 | .0210 | .0018 | 4.9 |
| " " 1903, | .30 | 13.16 | 2.52 | .3030 | .0262 | .0215 | .0047 | 1.74 | .0210 | .0024 | 4.4 |
| " " 1904, | .30 | 13.78 | 2.74 | .2399 | .0282 | .0214 | .0068 | 2.12 | .0408 | .0022 | 4.6 |
| " " 1905, | .21 | 16.34 | 2.55 | .3928 | .0246 | .0203 | .0043 | 2.65 | .0175 | .0025 | 5.0 |
| " " 1906, | .19 | 14.73 | 3.10 | .2218 | .0242 | .0200 | .0042 | 2.10 | .0252 | .0009 | 4.2 |

### *Blackstone River, at Millville.*

| Months. | Color. | Residue on Evaporation. | | Free Ammonia. | Albuminoid Ammonia. | | | Chlorine. | Nitrogen as | | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total. | Loss on Ignition. | | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | |
| June-Nov., 1887, | .31 | - | - | .0468 | .0220 | - | - | 0.51 | .0210 | - | - |
| " " 1888, | .41 | 5.22 | 1.40 | .0467 | .0296 | .0233 | .0063 | 0.50 | .0278 | .0004 | - |
| " " 1889, | .38 | - | - | .0499 | .0278 | .0218 | .0060 | 0.45 | .0167 | .0008 | - |
| " " 1890, | .26 | 6.71 | 2.24 | .0736 | .0196 | .0152 | .0044 | 0.53 | .0229 | .0008 | 2.3 |
| " " 1891, | .24 | 7.48 | 2.35 | .1105 | .0384 | .0234 | .0150 | 0.72 | .0308 | .0006 | 2.2 |
| " " 1892, | .37 | 6.70 | 1.62 | .1143 | .0294 | .0210 | .0084 | 0.63 | .0217 | .0002 | 2.0 |
| " " 1893, | .23 | 7.43 | 1.73 | .0677 | .0119 | .0087 | .0032 | 0.77 | .0385 | .0011 | 2.6 |
| " " 1894, | .47 | 8.42 | 2.16 | .0510 | .0172 | .0139 | .0033 | 0.89 | .0273 | .0012 | 2.8 |
| " " 1895, | .51 | 8.67 | 2.55 | .0356 | .0233 | .0180 | .0053 | 0.90 | .0383 | .0024 | 3.2 |
| " " 1896, | .35 | 8.53 | 1.69 | .0484 | .0237 | .0180 | .0057 | 0.97 | .0418 | .0027 | 3.3 |
| " " 1897, | .45 | 7.66 | 1.96 | .0509 | .0258 | .0210 | .0048 | 0.92 | .0445 | .0019 | 3.1 |
| " " 1898, | .51 | 7.12 | 2.17 | .0325 | .0240 | .0193 | .0047 | 0.63 | .0240 | .0023 | 2.5 |
| " " 1899, | .20 | 12.50 | 2.44 | .1310 | .0301 | .0247 | .0054 | 1.31 | .0310 | .0049 | 4.6 |
| " " 1900, | .29 | 9.33 | 1.82 | .1168 | .0254 | .0219 | .0035 | 1.15 | .0417 | .0039 | 3.4 |
| " " 1901, | .31 | 8.62 | 2.13 | .1420 | .0288 | .0227 | .0061 | 0.87 | .0155 | .0006 | 3.1 |
| " " 1902, | .28 | 9.43 | 2.24 | .1623 | .0284 | .0238 | .0046 | 1.20 | .0195 | .0010 | 2.8 |
| " " 1903, | .33 | 8.46 | 1.85 | .1397 | .0233 | .0189 | .0044 | 1.10 | .0192 | .0010 | 2.9 |
| " " 1904, | .29 | 8.71 | 2.06 | .1079 | .0235 | .0201 | .0034 | 1.26 | .0337 | .0009 | 2.9 |
| " " 1905, | .28 | 10.76 | 2.03 | .1956 | .0311 | .0222 | .0089 | 1.67 | .0207 | .0008 | 2.9 |
| " " 1906, | .37 | 9.02 | 2.15 | .1526 | .0306 | .0251 | .0055 | 1.27 | .0188 | .0006 | 2.4 |

NOTE. — The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1898, and since that time practically all of the dry-weather flow of sewage has been treated.

**MERRIMACK RIVER.**

## MERRIMACK RIVER.

*Table comparing the Analyses above Lowell with those above Lawrence, 1906.*

[Parts in 100,000.]

| | Color. | Residue on Evaporation. Total. | Residue on Evaporation. Loss on Ignition. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. Dis-solved. | Ammonia. Albuminoid. Sus-pended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean of analyses above Lowell, . | .38 | 4.17 | 1.65 | .0080 | .0194 | .0159 | .0035 | .21 | .0036 | .0002 | 1.0 |
| Mean of analyses above Lawrence, . | .40 | 4.73 | 1.93 | .0119 | .0239 | .0188 | .0051 | .31 | .0032 | .0003 | 1.2 |
| Increase, . . . . . . | .02 | 0.56 | 0.28 | .0039 | .0045 | .0029 | .0016 | .10 | .0004 | .0001 | 0.2 |

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years.

*Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.*

[Parts in 100,000.]

| Date. | Color. | Residue on Evaporation. Total. | Residue on Evaporation. Loss on Ignition. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. Dis-solved. | Ammonia. Albuminoid. Sus-pended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase, 1887-1889, . | 0.01 | 0.23 | 0.09 | .0007 | .0027 | .0017 | .0010 | .026 | .0003[1] | .0000 | - |
| Increase, 1890, . . | 0.05 | 0.62 | 0.22[1] | .0016 | .0023 | .0017 | .0006 | .028 | .0020[1] | .0000 | 0.2 |
| Increase, 1891, . . | 0.02[1] | 0.29 | 0.07 | .0021 | .0023 | .0021 | .0002 | .035 | .0030[1] | .0000 | 0.1 |
| Increase, 1892, . . | 0.06 | 0.48 | 0.12 | .0019 | .0037 | .0037 | .0000 | .039 | .0018[1] | .0000 | 0.0 |
| Increase, 1893, . . | 0.09 | 0.47 | 0.30 | .0031 | .0032 | .0021 | .0011 | .035 | .0002[1] | .0001 | 0.0 |
| Increase, 1894, . . | 0.02 | 0.15 | 0.04 | .0028 | .0032 | .0032 | .0000 | .049 | .0000 | .0000 | 0.1 |
| Increase, 1895, . . | 0.11 | 0.52 | 0.33 | .0022 | .0063 | .0046 | .0017 | .063 | .0005 | .0001 | 0.1 |
| Increase, 1896, . . | 0.02 | 0.51 | 0.24 | .0034 | .0053 | .0047 | .0006 | .070 | .0017 | .0002 | 0.2 |
| Increase, 1897, . . | 0.06 | 0.30 | 0.08 | .0019 | .0051 | .0033 | .0018 | .050 | .0000 | .0000 | 0.1 |
| Increase, 1898, . . | 0.03 | 0.37 | 0.07 | .0024 | .0039 | .0019 | .0020 | .044 | .0010 | .0002 | 0.1 |
| Increase, 1899, . . | 0.02 | 0.39 | 0.07 | .0038 | .0045 | .0023 | .0022 | .059 | .0004[1] | .0001 | 0.1 |
| Increase, 1900, . . | 0.03 | 0.41 | 0.11 | .0037 | .0027 | .0026 | .0001 | .055 | .0011 | .0000 | 0.0 |
| Increase, 1901, . . | 0.03 | 0.27 | 0.03 | .0032 | .0044 | .0023 | .0021 | .053 | .0020 | .0003 | 0.3 |
| Increase, 1902, . . | 0.03 | 0.52 | 0.20 | .0032 | .0063 | .0027 | .0036 | .060 | .0000 | .0001 | 0.1 |
| Increase, 1903, . . | 0.04 | 0.56 | 0.18 | .0043 | .0065 | .0045 | .0020 | .072 | .0014 | .0002 | 0.2 |
| Increase, 1904, . . | 0.02 | 0.31 | 0.06 | .0092 | .0047 | .0026 | .0021 | .100 | .0004[1] | .0001 | 0.1 |
| Increase, 1905, . . | 0.04 | 0.44 | 0.09 | .0047 | .0042 | .0024 | .0018 | .102 | .0003 | .0002 | 0.1 |
| Increase, 1906, . . | 0.02 | 0.56 | 0.28 | .0039 | .0045 | .0029 | .0016 | .100 | .0004[1] | .0001 | 0.2 |

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,484, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406, 7,389, 8,524, 9,160, 9,674, 7,410, 7,451 and 8,484 cubic feet per second.

[1] Decrease.

# WATER SUPPLY STATISTICS;

ALSO

## RECORDS OF RAINFALL AND FLOW OF STREAMS.

# WATER SUPPLY STATISTICS.

During the year 1906 water supplies were introduced into the towns of Edgartown (population, 1,175) and Oxford (population, 2,927) and into the Dracut Water Supply District. The village of Collinsville in the town of Dracut had been supplied previously.

Of the 354 cities and towns in Massachusetts, all of the 33 cities and 151 of the towns are provided with public water supplies. The following table gives a classification by population of the cities and towns having and not having public water supplies: —

| Population (1905). | Number of Places of Given Population having Public Water Supplies. | Total Population of Places in Preceding Column. | Number of Places of Given Population not having Public Water Supplies. | Total Population of Places in Preceding Column. |
|---|---|---|---|---|
| Under 500, | - | - | 36 | 12,513 |
| 500-999, | 4 | 3,755 | 50 | 36,782 |
| 1,000-1,499, | 14 | 16,949 | 36 | 44,942 |
| 1,500-1,999, | 13 | 23,445 | 22 | 38,534 |
| 2,000-2,499, | 13 | 28,293 | 15 | 32,174 |
| 2,500-2,999, | 13 | 35,009 | 2 | 5,517 |
| 3,000-3,499, | 8 | 25,943 | 2 | 6,441 |
| 3,500-3,999, | 5 | 18,931 | 3 | 11,394 |
| Above 4,000, | 114 | 2,644,267 | 4 | 18,791 |
| Totals, | 184 | 2,796,592 | 170 | 207,088 |

All of the towns except Blackstone having a population in excess of 5,000 are supplied with water, and there are only 9 towns in the State having a population in excess of 3,000 which are not provided with public water supplies. These towns are as follows: —

| Town. | Population in 1905. | Town. | Population in 1905. |
|---|---|---|---|
| Blackstone, | 5,786 | Dartmouth, | 3,793 |
| Tewksbury, | 4,415 | Templeton, | 3,788 |
| Barnstable, | 4,336 | Pepperell, | 3,268 |
| Chelmsford,[1] | 4,254 | Sutton, | 3,173 |
| Dudley, | 3,518 | | |

[1] Works under construction.

At the present time the water works are owned either by the municipality or by a fire or water supply district in all of the cities and 105 of the towns, while in 46 towns the works are owned by private companies. The following table gives a classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

| Population (1905). | Number of Places of Given Population owning Water Works. | Total Population of Places in Preceding Column. | Number of Places of Given Population supplied with Water by Private Companies. | Total Population of Places in Preceding Column. |
|---|---|---|---|---|
| Under 1,000, | 2 | 1,886 | 2 | 1,869 |
| 1,000-1,999, | 18 | 28,310 | 9 | 12,084 |
| 2,000-2,999, | 13 | 31,614 | 13 | 31,688 |
| 3,000-3,999, | 6 | 20,559 | 7 | 24,315 |
| 4,000-4,999, | 12 | 52,834 | 5 | 22,410 |
| 5,000-5,999, | 11 | 60,248 | 8 | 15,609 |
| 6,000-6,999, | 12 | 77,889 | 1 | 6,754 |
| 7,000-7,999, | 7 | 50,508 | 3 | 22,929 |
| Above 8,000, | 57 | 2,297,476 | 3 | 37,615 |
| Totals, | 138 | 2,621,319 | 46 | 175,273 |

From the totals given in the above tables it will be seen that the population of those towns supplied with water by private companies is only 6.3 per cent. of the total population in all of the cities and towns supplied with water, and that there are now only 3 towns having a population above 8,000 which are supplied by private companies. These are Hyde Park,[1] Milford and Southbridge.

## Rainfall.

The average rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 45.30 inches. The average rainfall for the year 1906 in these places was 43.21 inches, making a deficiency of 2.09 inches. There was an excess of rainfall in only four months, the greatest excess occurring in the months of March and May. There was a deficiency in each of the summer and fall months, the greatest deficiency occurring in the month of August.

The following table gives the normal rainfall in the State for each month, as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during 1906, and the departures from the normal: —

[1] The town of Hyde Park voted early in January, 1906, to take the works of the Hyde Park Water Company.

| Month. | Normal Rainfall (Inches). | Rainfall 1906 (Inches). | Excess or Deficiency 1906 (Inches). | Month. | Normal Rainfall (Inches). | Rainfall 1906 (Inches). | Excess or Deficiency 1906 (Inches). |
|---|---|---|---|---|---|---|---|
| January, | 3.88 | 2.71 | −1.17 | August, | 4.23 | 2.77 | −1.46 |
| February, | 3.71 | 3.00 | −0.71 | September, | 3.45 | 3.02 | −0.43 |
| March, | 4.17 | 5.93 | +1.76 | October, | 3.95 | 3.92 | −0.03 |
| April, | 3.55 | 2.63 | −0.92 | November, | 3.92 | 2.74 | −1.18 |
| May, | 3.66 | 4.91 | +1.25 | December, | 3.70 | 4.08 | +0.38 |
| June, | 3.33 | 3.81 | +0.48 | Total, | 45.30 | 43.21 | −2.09 |
| July, | 3.75 | 3.69 | −0.06 | | | | |

## Flow of Streams.

The flow of streams for the year 1906, as indicated by the records of the flow of the Sudbury River, was less than normal. The flow was in excess of the normal in only two months, — June and July. The greatest deficiency occurred in the months of February and March. In order to show the relation between the flow of the Sudbury River during each month of 1906 and the normal flow of that stream as deduced from observations during thirty-two years, from 1875 to 1906, inclusive, the following table has been prepared from data obtained from the Metropolitan Water and Sewerage Board. The drainage area of the Sudbury River above the point of measurement is 75.2 square miles.

| Month. | Normal Flow. | | Actual Flow for 1906. | | Excess or Deficiency. | |
|---|---|---|---|---|---|---|
| | Cubic Feet per Second per Square Mile. | Million Gallons per Day per Square Mile. | Cubic Feet per Second per Square Mile. | Million Gallons per Day per Square Mile. | Cubic Feet per Second per Square Mile. | Million Gallons per Day per Square Mile. |
| January, | 1.888 | 1.220 | 1.745 | 1.128 | −0.143 | −.092 |
| February, | 2.766 | 1.788 | 1.610 | 1.041 | −1.156 | −.747 |
| March, | 4.569 | 2.953 | 3.727 | 2.409 | −0.842 | −.544 |
| April, | 3.242 | 2.096 | 3.015 | 1.949 | −0.227 | −.147 |
| May, | 1.721 | 1.113 | 1.639 | 1.059 | −0.082 | −.054 |
| June, | 0.814 | .526 | 1.093 | .707 | +0.179 | +.181 |
| July, | 0.308 | .199 | .615 | .398 | +0.307 | +.199 |
| August, | 0.436 | .282 | .279 | .180 | −0.157 | −.102 |
| September, | 0.407 | .263 | .030 | .019 | −0.377 | −.244 |
| October, | 0.756 | .489 | .466 | .301 | −0.290 | −.188 |
| November, | 1.296 | .838 | .747 | .483 | −0.549 | −.355 |
| December, | 1.645 | 1.063 | 1.019 | .659 | −0.626 | −.404 |
| Year, | 1.648 | 1.065 | 1.331 | .860 | −0.317 | −.205 |

The next table shows the weekly fluctuations during 1906 in the flow of three streams which were carefully measured, namely, the Sudbury, south branch of the Nashua and the Merrimack rivers. The flow of these streams, particularly the Sudbury and the south branch of the Nashua, serves to indicate the flow of other streams in eastern Massachusetts. The flow of the Merrimack River is affected to some extent by the diversion of water from two of its branches for the water supply of the Metropolitan Water District. The quantity diverted in 1906 amounted to about 182 cubic feet per second, which would reduce the figures given for the flow per square mile of water-shed about .040 of a cubic foot per second. The water-shed of the Sudbury River is 75.2 square miles, of the Nashua 119 square miles, and of the Merrimack 4,664 square miles.

| Week ending Sunday. | Flow in Cubic Feet per Second per Square Mile of Water-shed. | | | Week ending Sunday. | Flow in Cubic Feet per Second per Square Mile of Water-shed. | | |
|---|---|---|---|---|---|---|---|
| | Sudbury River. | South Branch Nashua River. | Merrimack River. | | Sudbury River. | South Branch Nashua River. | Merrimack River. |
| 1906. | | | | 1906. | | | |
| Jan. 7, | 1.785 | 1.727 | 1.374 | July 8, | 1.730 | 1.663 | 1.713 |
| 14, | 1.345 | 1.214 | 1.009 | 15, | 0.392 | 0.726 | 0.955 |
| 21, | 2.078 | 2.089 | 1.263 | 22, | 0.157 | 0.832 | 0.776 |
| 28, | 1.996 | 2.212 | 2.982 | 29, | 0.059 | 0.881 | 0.808 |
| Feb. 4, | 0.985 | 1.016 | 1.326 | Aug. 5, | 0.669 | 1.390 | 1.061 |
| 11, | 0.832 | 0.731 | 0.763 | 12, | 0.707 | 1.019 | 0.784 |
| 18, | 0.631 | 0.984 | 0.753 | 19, | —0.229 | 0.500 | 0.590 |
| 25, | 3.390 | 2.911 | 1.282 | 26, | —0.162 | 1.006 | 0.519 |
| Mar. 4, | 4.283 | 3.780 | 1.799 | Sept. 2, | 0.783 | 0.816 | 0.550 |
| 11, | 4.563 | 2.539 | 2.183 | 9, | —0.237 | 0.331 | 0.460 |
| 18, | 2.169 | 1.404 | 1.201 | 16, | —0.414 | 0.280 | 0.387 |
| 25, | 1.418 | 1.438 | 0.910 | 23, | 0.478 | 0.662 | 0.374 |
| Apr. 1, | 5.624 | 5.428 | 2.640 | 30, | 0.252 | 0.507 | 0.405 |
| 8, | 3.171 | 3.154 | 2.988 | Oct. 7, | 0.575 | 0.328 | 0.400 |
| 15, | 4.965 | 5.798 | 3.573 | 14, | 0.201 | 0.597 | 0.418 |
| 22, | 2.846 | 2.702 | 5.070 | 21, | 0.588 | 0.941 | 0.499 |
| 29, | 1.166 | 1.525 | 2.472 | 28, | 0.848 | 1.482 | 0.650 |
| May 6, | 1.251 | 1.553 | 1.802 | Nov. 4, | 0.424 | 0.566 | 0.639 |
| 13, | 1.290 | 1.608 | 1.883 | 11, | 0.221 | 0.712 | 0.596 |
| 20, | 0.618 | 0.978 | 1.613 | 18, | 1.778 | 1.228 | 0.589 |
| 27, | 0.388 | 1.748 | 1.146 | 25, | 0.750 | 1.987 | 0.982 |
| June 3, | 4.902 | 5.627 | 4.928 | Dec. 2, | 0.408 | 0.947 | 0.713 |
| 10, | 1.078 | 1.527 | 2.293 | 9, | 0.723 | 0.904 | 0.540 |
| 17, | 0.943 | 1.965 | 1.565 | 16, | 0.247 | 1.149 | 0.516 |
| 24, | 1.333 | 2.437 | 2.336 | 23, | 1.600 | 1.229 | 0.557 |
| July 1, | 0.638 | 1.411 | 1.813 | 30, | 0.184 | 0.991 | 0.564 |

The following table gives the rainfall upon the Sudbury River water-shed and the yield of the stream expressed in inches in depth on the water-shed (inches of rainfall collected), for the year 1906, together with the average of the records for thirty-two years, from 1875 to 1906, inclusive: —

| Month. | 1906. | | | Mean for 32 Yrs. 1875–1906. | | |
|---|---|---|---|---|---|---|
| | Rainfall. | Rainfall collected. | Per Cent. collected. | Rainfall. | Rainfall collected. | Per Cent. collected. |
| January, | 2.47 | 2.012 | 81.5 | 4.19 | 2.176 | 52.0 |
| February, | 2.92 | 1.676 | 57.5 | 4.22 | 2.903 | 68.7 |
| March, | 6.32 | 4.297 | 68.1 | 4.60 | 5.263 | 114.5 |
| April, | 2.88 | 3.364 | 116.6 | 3.56 | 3.618 | 101.7 |
| May, | 5.66 | 1.890 | 33.4 | 3.35 | 1.984 | 59.2 |
| June, | 3.91 | 1.220 | 31.2 | 3.17 | 0.908 | 28.6 |
| July, | 3.42 | 0.709 | 20.7 | 3.72 | 0.355 | 9.6 |
| August, | 3.02 | 0.321 | 10.6 | 3.98 | 0.503 | 12.6 |
| September, | 3.30 | 0.034 | 1.0 | 3.43 | 0.454 | 13.2 |
| October, | 3.40 | 0.538 | 15.8 | 4.12 | 0.872 | 21.2 |
| November, | 2.69 | 0.834 | 31.1 | 3.86 | 1.446 | 37.5 |
| December, | 4.49 | 1.175 | 26.2 | 3.84 | 1.893 | 49.3 |
| Year, | 44.48 | 18.070 | 40.6 | 46.04 | 22.384 | 48.6 |

The Sudbury River records are particularly valuable as a basis for estimating the yield of other water-sheds in Massachusetts, both on account of the accuracy with which the measurements have been made and the absence of abnormal conditions which would unfavorably affect the results.

The following table gives the records of the yield of this water-shed for each year for the past thirty-two years, the flow from the water-shed being expressed in gallons per day per square mile of water-shed, in order to render the table more convenient for use in estimating the probable yield of water-sheds used as sources of water supply: —

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile.*[1]

| Month. | 1875. | 1876. | 1877. | 1878. | 1879. | 1880. | 1881. |
|---|---|---|---|---|---|---|---|
| January, | 108,000 | 643,000 | 658,000 | 1,810,000 | 700,000 | 1,121,000 | 415,000 |
| February, | 1,496,000 | 1,368,000 | 949,000 | 2,465,000 | 1,711,000 | 1,787,000 | 1,546,000 |
| March, | 1,604,000 | 4,435,000 | 4,813,000 | 3,507,000 | 2,380,000 | 1,374,000 | 4,004,000 |
| April, | 3,049,000 | 3,292,000 | 2,394,000 | 1,626,000 | 3,116,000 | 1,168,000 | 1,546,000 |
| May, | 1,188,000 | 1,139,000 | 1,391,000 | 1,394,000 | 1,114,000 | 514,000 | 965,000 |
| June, | 870,000 | 222,000 | 597,000 | 506,000 | 418,000 | 176,000 | 1,338,000 |
| July, | 321,000 | 183,000 | 202,000 | 128,000 | 158,000 | 177,000 | 276,000 |
| August, | 396,000 | 405,000 | 121,000 | 475,000 | 395,000 | 119,000 | 148,000 |
| September, | 207,000 | 184,000 | 60,000 | 160,000 | 141,000 | 80,000 | 197,000 |
| October, | 646,000 | 234,000 | 682,000 | 516,000 | 71,000 | 101,000 | 186,000 |
| November, | 1,302,000 | 1,088,000 | 1,418,000 | 1,693,000 | 206,000 | 205,000 | 395,000 |
| December, | 584,000 | 454,000 | 1,289,000 | 3,177,000 | 462,000 | 175,000 | 775,000 |
| Av. for whole year, | 972,000 | 1,135,000 | 1,214,000 | 1,452,000 | 894,000 | 578,000 | 979,000 |
| Av. for driest six months, | 574,000 | 384,000 | 502,000 | 582,000 | 230,000 | 143,000 | 330,000 |

| Month. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|---|---|---|
| January, | 1,241,000 | 835,000 | 995,000 | 1,235,000 | 1,461,000 | 2,589,000 | 1,053,000 |
| February, | 2,408,000 | 1,033,000 | 2,842,000 | 1,354,000 | 4,800,000 | 2,829,000 | 1,951,000 |
| March, | 2,839,000 | 1,611,000 | 3,785,000 | 1,572,000 | 2,059,000 | 2,868,000 | 3,237,000 |
| April, | 867,000 | 1,350,000 | 2,853,000 | 1,815,000 | 1,947,000 | 2,620,000 | 2,645,000 |
| May, | 1,292,000 | 938,000 | 1,030,000 | 1,336,000 | 720,000 | 1,009,000 | 1,632,000 |
| June, | 529,000 | 300,000 | 417,000 | 426,000 | 203,000 | 414,000 | 422,000 |
| July, | 86,000 | 115,000 | 224,000 | 62,000 | 115,000 | 114,000 | 117,000 |
| August, | 55,000 | 78,000 | 257,000 | 240,000 | 94,000 | 214,000 | 380,000 |
| September, | 306,000 | 91,000 | 44,000 | 121,000 | 118,000 | 111,000 | 1,155,000 |
| October, | 299,000 | 186,000 | 83,000 | 336,000 | 146,000 | 190,000 | 1,999,000 |
| November, | 210,000 | 205,000 | 175,000 | 1,178,000 | 673,000 | 368,000 | 2,758,000 |
| December, | 314,000 | 198,000 | 925,000 | 1,174,000 | 1,020,000 | 643,000 | 3,043,000 |
| Av. for whole year, | 862,000 | 533,000 | 1,129,000 | 901,000 | 1,087,000 | 1,154,000 | 1,697,000 |
| Av. for driest six months, | 211,000 | 145,000 | 200,000 | 391,000 | 223,000 | 234,000 | 953,000 |

[1] The area of the Sudbury River water-shed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The water-shed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile* — Continued.

| Month. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. |
|---|---|---|---|---|---|---|---|
| January, | 2,792,000 | 1,254,000 | 3,018,000 | 1,870,000 | 483,000 | 698,000 | 1,034,000 |
| February, | 1,195,000 | 1,529,000 | 3,486,000 | 948,000 | 1,542,000 | 991,000 | 541,000 |
| March, | 1,339,000 | 3,643,000 | 4,453,000 | 1,955,000 | 3,245,000 | 2,238,000 | 2,410,000 |
| April, | 1,410,000 | 1,875,000 | 2,397,000 | 871,000 | 2,125,000 | 1,640,000 | 2,515,000 |
| May, | 880,000 | 1,366,000 | 582,000 | 1,259,000 | 2,883,000 | 840,000 | 636,000 |
| June, | 653,000 | 568,000 | 414,000 | 428,000 | 440,000 | 419,000 | 174,000 |
| July, | 633,000 | 108,000 | 149,000 | 214,000 | 158,000 | 161,000 | 231,000 |
| August, | 1,432,000 | 132,000 | 163,000 | 280,000 | 181,000 | 209,000 | 229,000 |
| September, | 824,000 | 458,000 | 208,000 | 229,000 | 108,000 | 150,000 | 89,000 |
| October, | 1,230,000 | 2,272,000 | 210,000 | 126,000 | 221,000 | 374,000 | 1,379,000 |
| November, | 1,941,000 | 1,215,000 | 305,000 | 697,000 | 319,000 | 896,000 | 2,777,000 |
| December, | 2,241,000 | 997,000 | 544,000 | 485,000 | 797,000 | 716,000 | 1,782,000 |
| Av. for whole year, | 1,383,000 | 1,285,000 | 1,315,000 | 781,000 | 1,087,000 | 770,000 | 1,152,000 |
| Av. for driest six months, | 944,000 | 747,000 | 289,000 | 327,000 | 287,000 | 356,000 | 460,000 |

| Month. | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. |
|---|---|---|---|---|---|---|---|
| January, | 1,084,000 | 845,000 | 1,638,000 | 2,288,000 | 794,000 | 437,000 | 1,763,000 |
| February, | 2,676,000 | 1,067,000 | 3,022,000 | 1,381,000 | 3,800,000 | 300,000 | 1,674,000 |
| March, | 3,835,000 | 2,565,000 | 2,604,000 | 4,205,000 | 3,654,000 | 2,755,000 | 4,199,000 |
| April, | 1,494,000 | 1,515,000 | 1,829,000 | 2,521,000 | 1,350,000 | 4,204,000 | 1,885,000 |
| May, | 360,000 | 915,000 | 1,246,000 | 511,000 | 1,312,000 | 2,954,000 | 743,000 |
| June, | 399,000 | 962,000 | 530,000 | 66,000 | 316,000 | 753,000 | 303,000 |
| July, | 95,000 | 658,000 | 231,000 | 19,000 | —18,000 | 306,000 | 66,000 |
| August, | 57,000 | 591,000 | 1,107,000 | —85,000 | —34,000 | 424,000 | 135,000 |
| September, | 388,000 | 182,000 | 369,000 | 94,000 | 65,000 | 305,000 | 178,000 |
| October, | 592,000 | 94,000 | 1,160,000 | 115,000 | 186,000 | 412,000 | 506,000 |
| November, | 659,000 | 909,000 | 1,986,000 | 304,000 | 663,000 | 474,000 | 444,000 |
| December, | 657,000 | 1,584,000 | 1,799,000 | 220,000 | 1,096,000 | 2,695,000 | 1,779,000 |
| Av. for whole year, | 1,019,000 | 991,000 | 1,450,000 | 973,000 | 1,082,000 | 1,342,000 | 1,140,000 |
| Av. for driest six months, | 314,000 | 564,000 | 777,000 | 98,000 | 194,000 | 445,000 | 271,000 |

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile* — Concluded.

| MONTH. | 1903. | 1904. | 1905. | 1906. | Mean for 32 Years, 1875 to 1906, inclusive. |
|---|---|---|---|---|---|
| January, | 1,736,000 | 477,000 | 1,410,000 | 1,128,000 | 1,220,000 |
| February, | 2,279,000 | 883,000 | 330,000 | 1,041,000 | 1,788,000 |
| March, | 3,454,000 | 2,999,000 | 2,497,000 | 2,409,000 | 2,958,000 |
| April, | 2,261,000 | 3,294,000 | 1,643,000 | 1,949,000 | 2,096,000 |
| May, | 351,000 | 1,745,000 | 297,000 | 1,059,000 | 1,113,000 |
| June, | 1,987,000 | 419,000 | 467,000 | 707,000 | 526,000 |
| July, | 445,000 | 62,000 | 177,000 | 398,000 | 199,000 |
| August, | 307,000 | 170,000 | 114,000 | 180,000 | 282,000 |
| September, | 180,000 | 397,000 | 1,246,000 | 19,000 | 263,000 |
| October, | 492,000 | 191,000 | 158,000 | 301,000 | 489,000 |
| November, | 363,000 | 289,000 | 279,000 | 483,000 | 838,000 |
| December, | 582,000 | 269,000 | 887,000 | 659,000 | 1,063,000 |
| Average for whole year, | 1,190,000 | 931,000 | 795,000 | 860,000 | 1,065,000 |
| Average for driest six months, | 386,000 | 228,000 | 224,000 | 340,000 | 433,000 |

# EXPERIMENTS

UPON THE

# PURIFICATION OF SEWAGE AND WATER

AT THE

# LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1906.

# EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.[1]

By H. W. CLARK, *Chemist of the Board.*

The following report summarizes the results of all work upon the purification of sewage and water during the year ended Nov. 30, 1906. During this year a large number of sewage and water filters were in operation and many special studies were made. Data in regard to the work of, and the accumulation of organic matter in, the original sand filters, some of which have been in operation for nineteen years, are given as usual. Studies were made during the year in regard to the relative economy of operating sand filters so that organic matters are retained at the surface and removed from time to time with some of the filter sand, or operating them and mixing this organic matter from time to time with the upper layers of sand and depending upon natural agencies for its oxidation and removal. Sand filters were operated also to study systematically the maximum rate of satisfactory filtration that can be obtained with Lawrence sewage through such filters by different methods of application of the sewage. A number of contact and sprinkling, or trickling, filters were in operation and studies were made of methods for the efficient distribution of sewage over trickling filters and in regard to the attention needed to keep distributing devices in operation. A summary and comparison of the work of sand, contact and trickling filters in the actual disposition of organic matter reaching them is given in this report. Further studies were made of the clarification of the effluents of trickling filters, not only by the sand filters described in previous reports but also by coagulation and mechanical filtration, and investigations in regard to the purification of industrial wastes were continued as usual. The experiments upon the filtration of water of

[1] The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge. Mr. Stephen DeM. Gage and Mr. George O. Adams, the principal assistants of the writer at the station, have aided in the preparation of this report. A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water (1890). A similar account of the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports.

different degrees of pollution by slow sand filters and by mechanical filters operated at high rates with the aid of coagulants were continued during the year. Special attention was given to the question of double filtration both as regards the production of an effluent of a high degree of purity and with reference to economy of operation and maintenance. In the chemical laboratories extensive investigations were made of the suspended matters in sewage and in the effluents from filters of coarse materials in order to obtain a more complete knowledge of their chemical constituents. Much work was done to develop more comprehensive and rapid methods of bacteriological analysis and to determine the significance of the various factors which these methods may introduce in the interpretation of a complete water analysis. This work is summarized in a paper by Mr. Gage given below. Besides the work recorded in the following report, many chemical and bacterial analyses were made, as usual, of samples collected in connection with various investigations of the Board and forwarded to the station.

### Collection of Samples for Analysis.

Beginning Jan. 1, 1906, there were collected daily small samples of all sewage applied to Filters Nos. 1, 6 and 9A, and also of the effluents of all contact and trickling filters. These daily samples were mixed and preserved with chloroform and the average mixed samples were analyzed at the end of each month. The samples of sewage and effluent from the experimental plant of the Board at Andover were also collected and similarly treated. It has been found that more representative results are obtained from average samples collected in this manner than from single samples collected at intervals of one or more weeks.

### Analysis of Sewage.

The sewage used at the station is pumped through a 2½-inch pipe about 4,400 feet long. The sewage as received is a strong domestic sewage. The following tables present the results of the usual analyses of the various representative samples of sewage collected during the year, "Lawrence Street sewage" being the average of samples collected weekly from the sewer from which the sewage is pumped; "regular sewage" being the average of samples collected at the experiment station on at least four days of each week; "sewage applied to Filters Nos. 1, 6 and 9A" being the average of samples collected from all sewage applied to these filters, and "average sewage" being the average of all sewage pumped each Tuesday of the year. Besides these average analyses as presented in following tables, analyses were made regularly each week of the year of the sewage actually applied to trickling and contact

Filters Nos. 135, 136, 175, 176, 221, 222, 233, 235, 247, 248 and 251, and the results of these analyses are given in connection with the tables of analyses of the effluent of each of these filters. Especial attention has been called during the past three or four years to the amount of the Kjeldahl nitrogen work done and the present report contains many results of such work, 2,261 Kjeldahl determinations having been made during the year.

*Lawrence Street Sewage.*

[Parts per 100,000.]

| Date. | Temperature (Deg. F.). | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Free. | Albuminoid. | | | | | | | | |
| | | | Total. | In Solution. | Total. | In Solution. | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | |
| December, | 55 | 2.68 | 1.22 | .67 | 3.59 | 2.08 | 21.80 | .111 | .0080 | 15.52 | 658,000 |
| **1906.** | | | | | | | | | | | |
| January, | 52 | 2.90 | 0.91 | .47 | 2.94 | 1.74 | 8.58 | .075 | .0075 | 12.52 | 490,000 |
| February, | 58 | 2.70 | 1.18 | .59 | 3.61 | 2.11 | 11.00 | .095 | .0060 | 13.02 | 1,148,000 |
| March, | 52 | 2.10 | 0.96 | .59 | 2.76 | 1.79 | 9.80 | .098 | .0068 | 10.81 | 536,000 |
| April, | 59 | 2.90 | 0.98 | .49 | 3.38 | 2.17 | 11.17 | .132 | .0185 | 11.33 | 430,000 |
| May, | 62 | 3.18 | 1.06 | .50 | 3.08 | 1.94 | 15.33 | .107 | .0170 | 14.16 | 363,000 |
| June, | 66 | 2.84 | 0.97 | .49 | 2.84 | 1.86 | 16.98 | .098 | .0168 | 11.52 | 834,000 |
| July, | 70 | 2.68 | 0.97 | .46 | 2.66 | 1.58 | 18.68 | .074 | .0180 | 9.01 | 1,800,000 |
| August, | 75 | 2.06 | 0.78 | .48 | 2.49 | 1.67 | 14.66 | .040 | .0148 | 10.56 | 2,305,000 |
| September, | 73 | 2.62 | 0.81 | .50 | 2.28 | 1.58 | 13.42 | .053 | .0055 | 11.27 | 2,055,000 |
| October, | 66 | 2.77 | 0.95 | .58 | 2.87 | 1.95 | 13.50 | .089 | .0100 | 10.92 | 760,000 |
| November, | 58 | 2.90 | 1.05 | .57 | 3.21 | 1.97 | 15.26 | .088 | .0076 | 11.28 | 1,006,000 |
| Average, | 62 | 2.58 | 0.99 | .53 | 2.97 | 1.87 | 14.20 | .088 | .0115 | 11.83 | 1,025,400 |

*Regular Sewage.*

[Parts per 100,000.]

| Date. | Temperature (Deg. F.). | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|
| | | Free. | Albuminoid. | | | | | | |
| | | | Total. | In Solution. | Total. | In Solution. | | | |
| **1905.** | | | | | | | | | |
| December, | 38 | 7.49 | 1.01 | .56 | 2.20 | 1.16 | 10.07 | 7.28 | 2,327,000 |
| **1906.** | | | | | | | | | |
| January, | 39 | 6.59 | 0.98 | .51 | 2.00 | .96 | 11.77 | 6.62 | 1,175,300 |
| February, | 38 | 6.39 | 1.01 | .55 | 2.22 | 1.14 | 10.88 | 6.36 | 1,063,000 |
| March, | 39 | 5.93 | 0.94 | .51 | 1.76 | .91 | 13.71 | 5.89 | 852,000 |
| April, | 44 | 7.16 | 1.20 | .65 | 2.41 | 1.16 | 10.84 | 6.33 | 1,758,000 |
| May, | 56 | 6.23 | 1.02 | .53 | 1.77 | .84 | 14.08 | 5.75 | 1,093,000 |
| June, | 61 | 5.49 | 0.93 | .43 | 1.71 | .74 | 12.59 | 5.56 | 1,242,000 |
| July, | 70 | 5.81 | 0.79 | .35 | 1.46 | .61 | 16.87 | 4.74 | 5,664,000 |
| August, | 73 | 4.00 | 0.65 | .32 | 1.14 | .53 | 17.20 | 4.62 | 1,289,000 |
| September, | 69 | 4.58 | 0.70 | .36 | 1.22 | .56 | 18.26 | 5.04 | 984,700 |
| October, | 67 | 4.74 | 0.84 | .40 | 1.37 | .64 | 15.30 | 6.37 | 1,227,000 |
| November, | 50 | 5.10 | 0.97 | .47 | 1.68 | .78 | 14.51 | 6.69 | 910,700 |
| Average, | 54 | 5.79 | 0.92 | .47 | 1.75 | .84 | 13.84 | 5.94 | 1,632,100 |

*Station Sewage.*

[Parts per 100,000.]

| Date. | Temperature (Deg. F.). | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. Total. | Kjeldahl Nitrogen. In Solution. | Chlorine. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|
| **1905.** | | | | | | | | | |
| December, | 41 | 3.54 | 0.54 | .29 | 1.27 | .54 | 6.15 | 4.16 | 1,319,000 |
| **1906.** | | | | | | | | | |
| January, | 40 | 3.06 | 0.47 | .26 | .87 | .43 | 6.27 | 3.62 | 888,400 |
| February, | 37 | 2.81 | 0.49 | .28 | 1.12 | .56 | 5.65 | 4.00 | 709,000 |
| March, | 42 | 3.50 | 0.59 | .33 | 1.23 | .57 | 7.12 | 4.06 | 687,000 |
| April, | 46 | 4.86 | 0.80 | .40 | 1.50 | .69 | 8.16 | 4.49 | 1,157,000 |
| Average, | 41 | 3.55 | 0.58 | .31 | 1.20 | .56 | 6.67 | 4.07 | 952,000 |

*Average Sewage.*

| Date. | Temperature (Deg. F.). | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. Total. | Kjeldahl Nitrogen. In Solution. | Chlorine. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|
| **1905.** | | | | | | | | | |
| December, | 38 | 8.85 | 1.10 | .63 | 2.29 | 1.34 | 11.70 | 7.28 | 2,128,000 |
| **1906.** | | | | | | | | | |
| January, | 39 | 7.36 | 1.08 | .54 | 2.56 | 1.12 | 12.40 | 7.62 | 1,426,000 |
| February, | 38 | 6.40 | 1.00 | .49 | 2.26 | .96 | 11.59 | 6.15 | 818,000 |
| March, | 39 | 5.60 | 0.77 | .41 | 1.49 | .70 | 19.55 | 6.60 | 1,110,000 |
| April, | 44 | 6.05 | 1.05 | .53 | 2.06 | 1.00 | 9.15 | 6.65 | 1,940,000 |
| May, | 56 | 4.82 | 0.89 | .38 | 1.62 | .64 | 11.86 | 5.40 | 1,122,000 |
| June, | 62 | 6.25 | 0.88 | .44 | 1.57 | .82 | 11.48 | 5.50 | 1,206,000 |
| July, | 72 | 5.76 | 0.68 | .31 | 1.31 | .53 | 16.64 | 4.68 | 15,012,000 |
| August, | 73 | 4.35 | 0.74 | .34 | 1.34 | .58 | 16.73 | 5.08 | 1,430,000 |
| September, | 70 | 4.85 | 0.68 | .35 | 1.16 | .61 | 22.78 | 4.98 | 1,097,000 |
| October, | 62 | 5.34 | 1.01 | .42 | 1.60 | .68 | 14.42 | 7.16 | 1,763,300 |
| November, | 50 | 4.95 | 1.01 | .48 | 1.63 | .80 | 13.88 | 7.15 | 475,000 |
| Average, | 54 | 5.84 | 0.91 | .44 | 1.74 | .82 | 14.35 | 6.19 | 2,877,000 |

*Sewage applied to Filters Nos. 1, 6 and 9A.*

[Parts per 100,000.]

| Date. | Ammonia. Free. | Ammonia. Total Albuminoid. | Kjeldahl Nitrogen. | Chlorine. | Oxygen Consumed. |
|---|---|---|---|---|---|
| **1905.** | | | | | |
| December, | 4.20 | .52 | 1.00 | 6.58 | 3.97 |
| **1906.** | | | | | |
| January, | 3.38 | .49 | 0.88 | 6.45 | 3.58 |
| February, | 3.28 | .55 | 1.04 | 5.73 | 3.73 |
| March, | 4.50 | .69 | 1.22 | 7.73 | 5.17 |
| April, | 4.73 | .77 | 1.26 | 10.30 | 5.09 |
| May, | 5.90 | .97 | 1.76 | 17.45 | 5.53 |
| June, | 5.82 | .72 | 1.34 | 17.30 | 5.84 |
| July, | 5.35 | .72 | 1.24 | 18.01 | 4.58 |
| August, | 4.30 | .70 | 1.24 | 18.98 | 4.60 |
| September, | 4.28 | .67 | 1.15 | 16.56 | 5.38 |
| October, | 5.75 | .88 | 1.58 | 15.58 | 5.88 |
| November, | 5.68 | .99 | 1.64 | 14.28 | 7.08 |
| Average, | 4.72 | .72 | 1.28 | 12.91 | 5.04 |

### The Disposal of Organic Matter by Sand, Contact and Trickling Filters.

The primary object in sewage purification is to change by bacterial oxidation the putrefying matter or matters easily subject to putrefaction, present in sewage, to a more stable form, and by this means convert an ill-smelling, objectionable, badly polluted water to one free from odor and easily decomposable matter. Only a very small percentage of the total organic matter present in sewage is of this easily changeable nature, however, and it is the large remainder that accumulates in settling tanks and causes filter clogging. It was shown in last year's report, taking the Andover sewage for illustration,[1] that about one and one-half tons of sludge accumulated in the Andover settling tank per million gallons of sewage passing through. Average station sewage for the past eighteen years has contained about 2,080 pounds of suspended matter in each million gallons. Of this suspended matter, about 75 per cent. was organic. Of the organic matter, only 2 to 5 per cent. was organic nitrogen and the remainder was carbon and its compounds; about 40 per cent. was carbon, as shown by many analyses, and at times as much as 20 per cent. was fat or fatty matters. A series of tables is presented below showing clearly the actual amount of total organic matter and organic matter in suspension, applied during definite periods to representative sand, contact, and intermittent-continuous or trickling filters, stored by the same filters and passed on in their effluents. The sand filter employed in this study, Filter No. 1, was put into operation on Jan. 10, 1888; the intermittent-continuous or trickling filters, Nos. 135 and 136, on Nov. 28, 1899; the contact filters, Nos. 175 and 176, on June 3, 1901, and No. 221 on July 7, 1903. The average rate of filtration of Filter No. 1, up to June 25, 1906, when the last examinations of the filtering material were made, was 70,000 gallons per acre daily; of Filter No. 135, 1,442,000; of Filter No. 136, 1,397,000; of Filter No. 175, 622,000; of Filter No. 176, 596,000; and of Filter No. 221, 563,000 gallons per acre daily.

There has been practically no matter in suspension in the effluent of Filter No. 1, probably ninety-five of every one hundred samples collected showing none, and the other five containing so little that it would be lost in averaging, and it may be assumed that none of the organic or mineral matter in suspension in the sewage applied has appeared in the effluent. There has been applied to this filter with each million gallons of sewage about 375 pounds of nitrogen, and of this, 67.5 pounds, or 18 per cent., has been organic nitrogen. Of the total nitrogen applied.

[1] See page 362, report for 1905.

including both that in solution as well as that in suspension, about 55 per cent. has been oxidized and has appeared in the effluent; about 18 per cent. has been present in the effluent unoxidized; about 3 per cent. has been stored in the filter and 25 per cent. has been liberated by the nitrogen-liberating bacteria and passed into the air. Of the organic nitrogen applied, — largely nitrogen of the suspended matters, — about 65 per cent. has been oxidized; about 16 per cent. stored, and about 19 per cent. has disappeared through the action of nitrogen-liberating bacteria. The nitrogen in sewage, however, while forming an integral part of the portion of organic matter that is liable to quick putrefaction, the production of bad odors, etc., is but a small part of the total organic matter.

Of dry sludge, about 70 per cent. is organic matter, and of this only 2.5 per cent. is nitrogen, the remainder being carbon and its compounds. There has been applied to this filter in each million gallons of sewage about 2,800 pounds of organic matter, judging from loss-on-ignition results, and of this total, about 2,080 pounds has been organic matter in suspension in the sewage. There has been applied to this filter, taking these figures in connection with the rate of filtration, about 62,000 pounds of organic matter per acre of filter surface per year, and there has accumulated, as shown by analyses of the filtering material, about 10,500 pounds of organic matter per acre per year of service, and of this, only about 2.5 per cent. has been nitrogen. As 62,000 pounds have been applied each year, 17 per cent. of the total has been accumulated each year; but as the accumulation has been, of course, largely of the organic matter in suspension, the true comparison is with this; and of the 32,000 pounds of organic matter in suspension applied per acre per year the figures show a storage of 33 per cent. Of this stored matter, 65 per cent. is in the upper foot of filtering material, and, in spite of the relatively great storage, there is not enough present to prevent good operation of the filters and the production of a highly nitrified effluent. This organic matter, on account of the long period of storage of most of it and the resulting working over by bacteria, has been changed materially. Of the matters in suspension in Lawrence sewage, the fats are about 35 per cent. of the loss on ignition, but in the stored matter the fats are only about 2.8 per cent. of that loss. The amount of nitrogen in the suspended matter of the sewage is about 6 per cent. as much as the amount of carbon, while in the stored matters it is about 2.5 per cent.

The results of the many years of operation of this typical sand filter can be summarized as follows: At an average rate of 70,000 gallons per acre daily, a rate requiring 14.3 acres per million gallons of sewage cared for per day, it has produced a generally clear, highly nitrified, generally odorless effluent; has successfully disposed of putrefying nitrogenous

bodies in solution in the applied sewage and 84 per cent. of the organic nitrogen. It has oxidized and successfully disposed of 67 per cent. of the applied organic matter in suspension, both nitrogenous and carbonaceous, and has stored 33 per cent. of this matter. The residuum of organic matter stored is of an almost non-decomposable, stable nature and increases continually with continued use of the filter. It is probable, however, that the relative percentage stored will decrease and the percentage oxidized will increase as the filter continues in operation.

*Contact Filters.*

Coke contact Filters Nos. 175 and 176 had been in operation five years, while contact Filter No. 221, constructed of broken stone, had been in operation two and one-half years, when analyses of filtering material were made marking the end of the period covered by this discussion. The average rate of operation of the coke Filter No. 175 was about 621,000 gallons per acre daily; of coke Filter No. 176, 595,000 gallons per acre daily; and of the broken-stone filter, 530,000 gallons per acre daily, these rates being from seven and one-half to eight and one-half times as great as those of the sand filter.

There was applied to coke Filter No. 175 with each million gallons of sewage about 2,130 pounds of organic matter, this filter having received strained sewage; to Filter No. 176, 2,770 pounds; and to stone Filter No. 221, 2,810 pounds with each million gallons of sewage; or, in other words, taking into consideration the rate of filtration of each, 400,000 pounds per acre per year to coke Filter No. 175, 494,000 pounds to coke Filter No. 176 and 450,000 pounds per acre per year to stone Filter No. 221, or from six to eight times as much per acre per year to these filters as to the sand filter previously discussed. Each million gallons of sewage applied to coke Filter No. 175 contained on an average 800 pounds of suspended matter; each million gallons applied to Filter No. 176, 1,760 pounds; and each million gallons applied to Filter No. 221, 1,710 pounds of suspended matter; or 149,000, 314,000 and 278,000 pounds per acre per year to Filters Nos. 175, 176 and 221, respectively. Of the suspended matter, practically 75 per cent. was organic; and coke Filter No. 175 received 112,000 pounds of organic matter in suspension per acre per year; Filter No. 176, 236,000 pounds; and Filter No. 221, 206,000 pounds. Filter No. 175 received with each million gallons of sewage about 350 pounds of nitrogen, and of this, about 23 per cent., or 70 pounds, was organic nitrogen. The corresponding figures for Filters Nos. 176 and 221 are 390 and 78 pounds, and 380 and 114 pounds, respectively. Of the total nitrogen applied to Filters Nos. 175, 176 and 221, there appeared oxidized in the effluent of each 49, 19 and 4 per cent., respectively; 2, 1 and

10 per cent. of the total applied nitrogen was stored, and 18, 46 and 37 per cent. for each filter, respectively, was liberated. Of the organic nitrogen applied to Filters Nos. 175 and 176, 6 per cent. was stored; and Filter No. 221 stored 32 per cent. of the organic nitrogen applied. Of the total organic matter applied, Filter No. 175 stored 5 per cent., Filter No. 176, 6 per cent., and Filter No. 221, 26 per cent. Of the suspended solids in the sewage, they stored 13, 8 and 36 per cent., respectively; and of the organic matter in suspension applied they stored 17, 10 and 47 per cent., respectively; or, relatively, 60, 3.6 and 168 per cent. as much as by the sand filter already discussed. Of solids in suspension, Filter No. 175 stored 19,400 pounds per acre per year; Filter No. 176, 25,000 pounds per acre per year; and Filter No. 221, 98,000 pounds per acre per year. In other words, they stored 100, 135 and 610 pounds, respectively, of suspended matter for each million gallons of sewage applied, and of this stored matter 45 per cent. was organic. These filters produced effluents of varying character: Filters Nos. 175 and 176, effluents with much of the easily putrescible matter of the sewage oxidized or removed, and hence, generally, stable effluents, notwithstanding the large amount of organic matter present; while Filter No. 221 produced, much of the time, an effluent subject to putrefaction. These filters require about 1.7 acres of surface per million gallons of sewage per day.

### *Sprinkling Filters.*

For the third comparison of the disposition of matter by filtration, the results yielded by two sprinkling filters that have been in operation eight years are presented. These two filters are constructed of broken stone, and have received sewage at an average rate of 1,450,000 gallons per acre daily. During some of the years of their operation they have received raw sewage, and during other years sewage from which a portion of the matters in suspension had been removed either by septic tanks or mechanical strainers. Averaging the results, the following data are obtained: With each million gallons of sewage there was applied 2,300 pounds of total organic matter and 875 pounds of organic matter in suspension, or about 381,000 pounds of organic matter in suspension in the sewage applied to each filter per acre per year. The filters stored 2 per cent. of the organic solids applied, or 23,000 pounds per acre per year; 4 per cent. of the total suspended solids applied; and the stored organic solids are about 5½ per cent. of the organic matter in suspension in the applied sewage. There was applied with each million gallons of sewage 375 pounds of nitrogen, and of this about 17 per cent., or 64 pounds, was organic nitrogen. To each filter there was applied 32,000 pounds of organic nitrogen per acre per year, this organic nitrogen

being about 7½ per cent. of the applied suspended solid matters. The filters stored 1 per cent. of the total nitrogen applied and 6 per cent. of the organic nitrogen; 42 per cent. of the applied nitrogen appeared oxidized in the effluent, 43 per cent. appeared unoxidized, 14 per cent. was liberated and 1 per cent. was stored.

*Summary.*

All these results show clearly the true function and action of the three classes of filters in handling the large amount of fairly stable matter, organic and mineral, that reaches them. Oxidation of the matter actually putrefying at the time of application of the sewage is generally accomplished easily by any properly constructed and operated filter. This being done, a good sand filter, owing to oxidation and straining, produces a clear, odorless and highly nitrified effluent. The rate at which it can be operated is limited, however, and can rarely exceed 100,000 gallons per acre daily when receiving a normally strong sewage. Preliminary treatments of the sewage, of course, allow this rate to be materially increased. Contact filters allow rates six to eight times as great as sand filters, but only the best give non-putrescible effluents; and trickling filters can be operated with normal sewage at rates at least three or four times as great as contact filters and twenty times as great as sand filters, with the production of a highly nitrified, practically odorless and non-putrescible effluent, — generally a quite turbid effluent, however. Sand filters, owing to their comparatively low rate of operation, are many years in accumulating enough stable organic matter to necessitate removal or to cause difficulty in operation. A considerable percentage of that applied does, however, accumulate. The best of contact filters, on the other hand, and good trickling filters succeed in oxidizing the putrefying matters present in the sewage as applied to them, and, owing to the nature of the materials of which they are constructed, pass along a very large percentage of the non-putrefying, stable organic and mineral matters of the applied sewage. The percentage of this matter stored by trickling filters at Lawrence is slight, and apparently does not gain beyond a certain point in the best filters, as shown by our analyses and examinations. The peeling of this matter from the filtering materials at times of bacterial activity and its passage in large quantities into the effluent has been frequently noted.

This presentation is simply a collection of data to show with some degree of accuracy what the final problem of sewage disposal really is. It is no longer believed that bacterial action in properly constructed filter beds can dispose of all organic matter. Much of it is too stable for such disposition and it will accumulate. In sand filters its accumulation is slow because the rate of filtration is necessarily low. There is much

talk at the present time of higher rates of filtration through such filters, but this high rate means simply poorer purification and frequent sand removal. Sprinkling filters and the best contact filters give a much lower degree of purification, estimated by the matter strained out, but allow the greater rates shown here, oxidize the putrefying matters and pass along a large percentage of the stable matter.

*Data on Storage of Applied Suspended Matters. — Filters Nos. 1, 135, 136, 175, 176 and 221.*

| | PERIOD COVERED. | | | | | |
|---|---|---|---|---|---|---|
| | JAN. 10, 1888– JUNE 25, 1896. | NOV. 28, 1899– FEB. 5, 1906. | | JUNE 3, 1901– OCT. 16, 1906. | | JULY 7, 1903– FEB. 5, 1906. |
| | Filter No. 1. | Filter No. 135. | Filter No. 136. | Filter No. 175. | Filter No. 176. | Filter No. 221. |
| Total days operated, | 5,799 | 2,108 | 2,108 | 1,684 | 1,684 | 812 |
| Million gallons applied per acre, | 406 | 2,944 | 3,155 | 1,044 | 1,010 | 447 |
| *Pounds applied per Million Gallons.* | | | | | | |
| Organic solids (loss on ignition), | 2,800 | 2,330 | 2,250 | 2,130 | 2,770 | 2,810 |
| Total solids in suspension, | 2,080 | 1,280 | 1,065 | 800 | 1,760 | 1,710 |
| Organic solids in suspension, | 1,518 | 950 | 790 | 580 | 1,320 | 1,280 |
| Total nitrogen, | - | 380 | 370 | 330 | 390 | 380 |

*Comparative Disposal of Organic Matter by Sand, Contact and Sprinkling Filters.*

| | Sand Filter. | Sprinkling Filter. | | Contact Filter. | | |
|---|---|---|---|---|---|---|
| | | No. 135. | No. 136. | No. 175. | No. 176. | No. 221. |
| Per cent. of applied matter stored in filters: — | | | | | | |
| Total nitrogen, | 3.0 | 1 | 1 | 2 | 1 | 10 |
| Organic nitrogen, | 16.0 | 6 | 6 | 6 | 6 | 32 |
| Organic solids, | - | 2 | 2 | 5 | 6 | 26 |
| Solids in suspension, | 33.0 | 4 | 4 | 13 | 8 | 36 |
| Percentages of organic matter and organic nitrogen applied and stored: — | | | | | | |
| Organic matter in solids in suspension, | 70.0 | 74 | 74 | 73 | 75 | 75 |
| Organic nitrogen in solids in suspension, | 3.3 | 6 | 9 | 6 | 5 | 5 |
| Organic nitrogen in stored matter, | 2.5 | 8 | 8 | 3 | 6 | 6 |
| Organic matter in stored matter, | - | 55 | 60 | 45 | 46 | 43 |
| Stored organic matter to suspended organic matter in applied sewage, | 33.0 | 5 | 6 | 17 | 10 | 47 |
| Pounds of organic matter applied and stored: — | | | | | | |
| Total in suspension, applied per acre per year, | 32,000 | 420,000 | | 112,000 | 236,000 | 206,000 |
| Stored per acre per year, | 10,500 | 23,000 | | 19,000 | 25,000 | 50,000 |
| Stored per 1,000,000 gallons of sewage applied, | 477 | 48 | 50 | 100 | 135 | 610 |
| Per cent. of applied nitrogen: — | | | | | | |
| In effluent, oxidized, | 55.0 | 37 | 47 | 49 | 19 | 4 |
| In effluent, unoxidized, | 18.0 | 39 | 47 | 31 | 34 | 49 |
| Stored in filter, | 3.0 | 1 | 1 | 2 | 1 | 10 |
| Liberated,[1] | 25.0 | 23 | 5 | 18 | 46 | 37 |

[1] By difference.

## Work of Trickling and Contact Filters in disposing of Matters in Suspension in Sewage.

For several years determinations have been made of the matters in suspension in the effluents of trickling and contact filters. The larger the amount of matter in suspension in these effluents, the greater the life of the filter before cleaning; and the more correct the adjustment of the size and depth of filtering material and the rate of filtration to give good nitrification and a non-putrescible effluent, and at the same time allow the eventual passage of suspended matter through the filter after its proper working over by bacteria, the more successful the filter from an economic point of view. On previous pages attention has been called to the large amount of suspended matter passed on by these filters. In the previous table, however, these figures were given in terms of pounds per year per acre of filter surface, etc. In the following table the results are given for a period of several years, showing the amount of this matter in parts per 100,000 and pounds per million gallons of effluent. The large amount of this matter that is passed on by trickling Filters Nos. 135 and 136 and the comparatively small amount by even the best contact filters at the station — Nos. 175 and 176 — is noticeable, and especially noticeable is the difference in this respect between the trickling filters and contact Filter No. 221, constructed of the same material as the trickling filters and operating at a very much lower rate. Further tables show the actual amount of stored matter per cubic foot of filtering material in coke contact Filters Nos. 175, 176 and stone contact Filter No. 221, also trickling Filters Nos. 135, 136, 247, 248, — constructed of broken stone, — and Filters Nos. 233 and 235, constructed of clinkers. The date of these examinations and the length of period of operation when made are given on the tables, together with analyses of the stored material. The large amount of matter retained in contact Filter No. 221 in comparison with the small amount retained in trickling Filters Nos. 135 and 136 is especially noticeable.

*Solids in Suspension in Effluents.*

[Parts per 100,000.]

| Year. | Filter No. 135. | | Filter No. 136. | | Filter No. 175. | | Filter No. 176. | | Filter No. 221. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | Organic. | Total. | Organic. | Total. | Organic. | Total. | Organic. | Total. | Organic. |
| 1902, . . | 7.7 | 3.6 | 11.6 | 6.1 | 1.6 | 1.1 | 3.9 | 2.2 | – | – |
| 1903, . . | 4.3 | 2.1 | 8.1 | 3.7 | 3.7 | 2.9 | 2.6 | 1.3 | – | – |
| 1904, . . | – | – | 13.8 | 8.1 | 2.6 | 1.8 | 5.7 | 3.2 | 5.0 | 2.6 |
| 1905, . . | 7.3 | 4.8 | 10.6 | 6.4 | 2.8 | 1.9 | 2.0 | 1.0 | 3.7 | 1.6 |
| 1906, . . | – | – | 18.9 | 15.3 | 4.8 | 1.9 | 2.4 | 1.5 | 3.1 | 2.1 |

*Solids in Suspension in Effluents* — Concluded.

[Pounds per Million Gallons.]

| Year. | Filter No. 135. | | Filter No. 136. | | Filter No. 175. | | Filter No. 176. | | Filter No. 221. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | Organic. | Total. | Organic. | Total. | Organic. | Total. | Organic. | Total. | Organic. |
| 1902, . . | 641 | 300 | 916 | 508 | 134 | 92 | 325 | 183 | - | - |
| 1903, . . | 358 | 175 | 675 | 309 | 309 | 242 | 217 | 108 | - | - |
| 1904, . . | - | - | 1,150 | 675 | 217 | 150 | 475 | 267 | 417 | 217 |
| 1905, . . | 608 | 401 | 888 | 534 | 234 | 157 | 167 | 88 | 309 | 134 |
| 1906, . . | - | - | - | - | - | - | - | - | - | - |

*Pounds of Matter stored per Cubic Foot of Filtering Material in Filters Nos. 135, 136, 221, 247, 175, 176, 233, 235 and 248.*

| Filter Nos. | Pounds per Cubic Foot. | Filter Nos. | Pounds per Cubic Foot. |
|---|---|---|---|
| 135, . . . . . . . . | 0.53 | 176, . . . . . . . . | 1.36 |
| 136, . . . . . . . . | 0.54 | 233, . . . . . . . . | 0.41 |
| 221, . . . . . . . . | 3.77 | 235, . . . . . . . . | 1.20 |
| 247, . . . . . . . . | 2.28 | 248, . . . . . . . . | 0.25 |
| 175, . . . . . . . . | 1.06 | | |

*Analysis of Stored Matter.*

[Per Cent. by Weight.]

| Filter Nos. | Ammonia. | | Kjeldahl Nitrogen. | Carbon. | Hydrogen. | Loss on Ignition. | Fats. | Albuminoid Nitrogen. |
|---|---|---|---|---|---|---|---|---|
| | Free. | Albuminoid. | | | | | | |
| 135, . . . . . . . . | .20 | 2.04 | 4.00 | 28.47 | 3.79 | 55.0 | 4.05 | 1.67 |
| 136, . . . . . . . . | .23 | 2.17 | 4.76 | 31.24 | 3.91 | 60.2 | 3.82 | 1.78 |
| 221, . . . . . . . . | .02 | 1.40 | 2.87 | 22.02 | 2.84 | 43.3 | 2.50 | 1.15 |
| 247, . . . . . . . . | .01 | 1.45 | 3.76 | 22.49 | 3.71 | 50.7 | 5.78 | - |
| 175, . . . . . . . . | .16 | 1.30 | 2.50[1] | - | - | 45.1 | - | 1.07 |
| 176, . . . . . . . . | .20 | 1.40 | 2.84[1] | - | - | 46.3 | - | 1.15 |
| 233, . . . . . . . . | - | 1.50 | 3.14[1] | - | - | 48.7 | - | - |
| 235, . . . . . . . . | - | 2.20 | 3.72[1] | - | - | 44.5 | - | - |
| 248, . . . . . . . . | - | 2.20 | 3.51[1] | - | - | 51.8 | - | - |

[1] Including free ammonia.

## Oxidation, Liberation and Storage of Organic Nitrogen.

In the last two reports various tables were given showing the percentage of the *total nitrogen* applied to filters that is oxidized, liberated or stored. The following table is presented to show the action of the filter upon *organic nitrogen* only, measured by albuminoid ammonia determinations. The figures in this table are based upon results obtained during the entire period of operation of each filter presented in the table, or up to the last examination of filtering material. The figures presented are of sand Filters Nos. 1, 2, 4, 5A, 5C, 6 and 9A, contact Filters Nos. 103, 175, 176 and 221, and trickling Filters Nos.

135, 136, 233, 235, 247 and 248. These figures show clearly the different disposition of this organic nitrogen by the different classes of filters; the large percentage of oxidation or liberation by sand filters, together with the small amount passing away unoxidized in their effluents and the comparatively large storage, and the large percentage passing away unoxidized in the effluents of contact and trickling filters and the generally small storage. Contact Filter No. 221 and trickling Filter No. 247 have stored as much as, or more than, the sand filters; but these filters are exceptions to the general rule, and the storage has been due to causes not yet entirely understood, but probably on account of the use of a small percentage of fine stone, this stone choking the channels between the larger pieces of stone.

| Filter Nos. | Period of Operation. | Number of Days operated. | Albuminoid Nitrogen (Pounds per Acre). | | | | Per Cent. of Applied Albuminoid Nitrogen. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Applied. | In Effluent. | Stored in Filter. | Oxidized and liberated. | In Effluent. | Stored in Filter. | Oxidized and liberated. |
| 1 | Jan. 10, 1888, June 25, 1906, | 5,799 | 19,709 | 1,971 | 2,860 | 14,878 | 10.0 | 14.5 | 75.5 |
| 2 | Dec. 19, 1887, Oct. 3, 1906, | 5,885 | 10,520 | 446 | 1,756 | 8,318 | 4.3 | 16.7 | 79.0 |
| 4 | Dec. 19, 1887, Oct. 3, 1906, | 5,885 | 6,824 | 193 | 2,132 | 4,499 | 2.8 | 31.2 | 66.0 |
| 5A | Sept. 14, 1891, March, 1898, | 3,187 | 12,743 | 1,858 | 1,547 | 9,338 | 14.5 | 12.1 | 73.4 |
| 5C | July 20, 1905, July 23, 1906, | 315 | 777 | 34 | 359 | 384 | 4.4 | 46.2 | 49.4 |
| 6 | Jan. 12, 1888, June 25, 1906, | 5,797 | 16,032 | 1,111 | 5,040 | 9,881 | 6.9 | 31.4 | 61.7 |
| 9A | Nov. 18, 1890, June 25, 1906, | 4,904 | 16,422 | 1,389 | 2,918 | 12,120 | 8.5 | 17.7 | 73.8 |
| 103 | Mar. 1, 1898, June 30, 1904, | 1,984 | 36,544 | 10,872 | 6,743 | 18,929 | 29.9 | 18.4 | 51.7 |
| 135 | Nov. 28, 1899, Feb. 5, 1906, | 2,103 | 110,363 | 42,744 | 4,249 | 63,370 | 38.6 | 3.9 | 57.5 |
| 136 | Nov. 28, 1899, Feb. 5, 1906, | 2,103 | 102,831 | 49,926 | 4,483 | 48,422 | 48.6 | 4.4 | 47.0 |
| 175 | June 3, 1901, Oct. 16, 1906, | 1,684 | 34,059 | 12,960 | 2,473 | 18,626 | 38.1 | 7.3 | 54.6 |
| 176 | June 3, 1901, Oct. 16, 1906, | 1,684 | 45,719 | 13,185 | 3,398 | 29,136 | 28.9 | 7.5 | 63.6 |
| 221 | July 7, 1903, Feb. 5, 1906, | 812 | 22,362 | 8,705 | 7,227 | 6,430 | 39.0 | 32.3 | 28.7 |
| 233 | Jan. 1, 1904, Oct. 16, 1906, | 874 | 40,162 | 18,515 | 1,107 | 20,540 | 46.1 | 2.8 | 51.1 |
| 235 | Jan. 1, 1904, Oct. 16, 1906, | 874 | 37,957 | 16,572 | 4,726 | 16,659 | 43.7 | 12.4 | 43.9 |
| 247 | May 16, 1904, April 6, 1906, | 594 | 32,132 | 17,130 | 5,921 | 9,081 | 53.2 | 18.5 | 28.3 |
| 248 | May 16, 1904, Oct. 16, 1906, | 758 | 43,104 | 35,464 | 1,588 | 6,052 | 82.3 | 3.7 | 14.0 |

## Summary of Purification and Nitrogen Disposal accomplished by Trickling Filters.

The first trickling filters — although not at that time so designated — put into operation at the station were Nos. 15B and 16B. These filters, constructed of stone, were in operation from June, 1892, until the end of 1897, and were operated at times at rates as high as 500,000 gallons per acre daily, the average rate of operation being about 370,000 gallons per acre daily. They produced highly nitrified and stable effluents. In 1899 Filter No. 117, constructed of broken stone and 10½ feet in depth, and Filter No. 134, of the same material but only 5 feet in depth, were put into operation. The average rate of filtration of Filter No. 117 was 1,897,000 gallons per acre daily, and of Filter No. 134, 1,150,000 gallons per acre daily. Both filters produced highly nitrified and generally stable effluents. Following this, Filters Nos. 131, 189, 135, 136, 196, 222, 233, 234, 235, 236, 247 and 248, all trickling or, as first named, intermittent-continuous filters, but of varying depth and material, were operated. Of these, several of the most important and instructive are continued. In order that the general results of the operation of all these filters to date may be of ready reference, and also to show the work of each in handling the organic matter applied to them, various tables are given below in connection with the trickling filter results for 1906. The first set of tables shows the rate of operation and the analysis of the effluent of each filter; the second set of tables shows the actual amount of nitrogen applied, the amount oxidized, etc.

## Sedimentation of Matters in Suspension in Effluents of Trickling and Contact Filters.

It is possible by sedimentation to remove a large percentage of the matters in suspension in the effluents of trickling filters, and by this means to collect a large amount of organic and mineral matter and pass along the clearer effluent. Each of the trickling filters at the station is provided with a settling basin into which the effluents flow, and experiments made by the frequent collection of samples of effluent entering and flowing from these basins show that from 60 to 80 per cent. of the matters in suspension in the effluents remain in the tanks. The quickest removal by this means occurs in the effluents of the filters giving the best nitrification. In such effluents the particles in suspension gather in larger aggregations than in the less efficiently purified effluents. The percentage of sedimentation increases also as the matter in suspension increases. Experiments in regard to the amount of matter that will settle out from such effluents in two hours were made during the year, and resulted as follows: —

*Rates at which the Sediment settles out from the Effluents of Various Filters.*

[Glass tubes were filled to a depth of 6 feet with the samples and allowed to stand two hours, when a sample was siphoned from midway down the tube.]

*Total Solids in Suspension.*

[Parts per 100,000.]

| Trickling Filters Nos. | At the Start. | After Two Hours' Sedimentation. | Per Cent. settling out in Two Hours. | Contact Filters Nos. | At the Start. | After Two Hours' Sedimentation. | Per Cent. settling out in Two Hours. |
|---|---|---|---|---|---|---|---|
| 135, . . . | 15.7 | 3.3 | 78.7 | 175, . . . | 6.1 | 4.3 | 29.0 |
| 136, . . . | 8.6 | 4.6 | 48.0 | 176, . . . | 5.8 | 5.8 | 0.0 |
| 233, . . . | 7.7 | 3.3 | 58.3 | 221, . . . | 7.0 | 6.7 | 4.0 |
| 235, . . . | 20.6 | 3.7 | 80.5 | 237, . . . | 4.0 | 2.7 | 31.5 |
| 247, . . . | 5.4 | 4.2 | 29.5 | 251, . . . | 3.9 | 3.0 | 28.5 |
| 248, . . . | 12.5 | 6.1 | 48.0 | | | | |

The average suspended matter in the effluents from the trickling filters and the settling tanks receiving these effluents from May to November, 1906, was as follows, the time of sedimentation in these tanks varying from two to six hours: —

*Suspended Matter.*

[Parts per 100,000.]

| | Filters Nos. — | | | |
|---|---|---|---|---|
| | 135 and 136. | 233 and 235. | 247. | 248. |
| Effluent of filter, . . . . . . . | 10.1 | 9.9 | 16.6 | 14.8 |
| Effluent of settling tank, . . . . . | 2.5 | 2.1 | 6.4 | 5.6 |
| Per cent. removed by settling tank, . . | 75.0 | 79.0 | 61.0 | 62.0 |

*Average Solids in Combined Effluents of Filters Nos. 135 and 136.*

[Parts per 100,000.]

| Year. | Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 1906, . . . | 75.3 | 20.5 | 54.8 | 65.2 | 13.8 | 51.4 | 10.1 | 6.7 | 3.4 |

*Average Solids in Effluent of Settling Tank receiving Effluent of Filters Nos. 135 and 136.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 54.6 | 9.6 | 45.0 | 52.1 | 7.8 | 44.3 | 2.5 | 1.8 | 0.7 |

*Average Solids in Combined Effluents of Filters Nos. 233 and 235.*

[Parts per 100,000.]

| Year. | Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 1906, . . . | 60.8 | 14.5 | 46.3 | 50.8 | 7.9 | 42.9 | 9.9 | 6.6 | 3.3 |

*Average Solids in Effluent of Settling Tank receiving Effluent of Filters Nos. 233 and 235.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 53.4 | 10.3 | 43.1 | 51.2 | 8.5 | 42.7 | 2.1 | 1.8 | 0.3 |

*Average Solids in Effluent of Filter No. 247.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 70.8 | 18.4 | 52.4 | 54.2 | 8.3 | 45.9 | 16.6 | 10.2 | 6.4 |

*Average Solids in Effluent of Settling Tank receiving Effluent of Filter No. 247.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 54.1 | 11.4 | 42.7 | 47.8 | 7.6 | 40.2 | 6.4 | 3.8 | 2.6 |

*Average Solids in Effluent of Filter No. 248.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 64.1 | 17.7 | 46.4 | 49.3 | 8.2 | 41.1 | 14.8 | 9.5 | 5.3 |

*Average Solids in Effluent of Settling Tank receiving Effluent of Filter No. 248.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1906, . . . | 57.1 | 12.7 | 44.4 | 51.6 | 9.1 | 42.5 | 5.6 | 3.6 | 2.0 |

## Incubation Tests.

### *Determination of Putrescibility of Effluents.*

The surest indication of putrescibility in the effluent of a sewage filter is an increased odor and blackening of the liquid when standing in closed bottles in a warm place. Determinations of dissolved oxygen and oxygen consumed before and after incubation are of value as confirmatory evidence. During 1902, 1903 and 1904 the appearance and odor of the effluents of all contact and trickling filters were noted, and oxygen consumed and oxygen dissolved were determined before and after five days' incubation. Samples which developed an offensive odor, increased oxygen consumed, and exhaustion of dissolved oxygen after

incubation, were recorded as putrefying. In some samples the oxygen consumed increased and dissolved oxygen disappeared, but offensive odors did not develop, the samples remaining a long time without change in this respect; and such samples cannot truly be said to putrefy, but are subject to bacterial and chemical changes that do not cause offence.

Beginning in May, 1906, samples of the effluents from all contact and trickling filters in operation at the station were incubated as follows: (1) samples of effluent as flowing from the filters containing all matters in suspension; (2) samples of the supernatant effluent after three hours' sedimentation, this sedimentation causing removal of much of the matters in suspension; (3) samples coming from the filter, but with the addition of 50 per cent. Lawrence tap water; and (4) samples to which methylene-blue was added.

During this period eleven samples of the unsettled effluents putrefied, and nine of the same effluents, after three hours' sedimentation and the removal of suspended matter, also putrefied upon incubation, these samples all coming from filters giving the poorest effluents, namely, Filters Nos. 221 and 247. (A description of all these filters will be given later in this report.) Of the eleven samples, four, all from one filter, putrefied even when mixed with 50 per cent. of Lawrence tap water. All of the samples from trickling filters during this period, the effluents of which showed good oxidation and nitrification, were non-putrescible according to each and all of these tests.

It was apparent from this work that when efficient oxidation was occurring in these filters, the soluble matters in the applied sewage being well oxidized, the suspended matters in the effluents had little tendency to become objectionable. Of the eleven samples of entire effluent which putrefied, nine putrefied after the removal of this sediment, showing that it was the matters in solution rather than those in suspension that caused the change.

The use of methylene-blue was tried, as it has been recommended by different laboratories, but its disappearance has apparently little value as an indication of putrescibility. The color disappears as soon as a reducing action takes place in the sample, and this reducing action frequently is not accompanied by putrefaction. Non-disappearance of the color means, of course, non-putrescibility of the sample.

The following tables present not only the results obtained during 1906, but also those of incubation tests of previous years. A study of the results shows that the effluents of the trickling filters of good materials, of sufficient depth, etc., are, as has been stated many times in

these reports, practically non-putrescible. The effluents from trickling filters constructed of material poorly adapted to the work, or of insufficient depth, etc., such as Filters Nos. 189, 236 and 247, are often putrescible, and the analytical results from these filters have shown that this was to have been expected. The effluents of contact filters are more liable to putrefaction than the effluents of trickling filters, as shown by the tables. The best contact filters show generally considerably less than 25 per cent. of samples liable to putrefaction, and occasionally a contact filter will produce an effluent month after month, none of the samples from which will putrefy. The poorer filters of this class, however, produce effluents of which 25 to 90 per cent. of the samples collected undergo putrefaction.

*Incubation Tests.— Trickling Filters.*

| Filter No. | Period during which Incubations were made. | Number of Samples incubated. | Per Cent. of Samples which putrefied. | Average Rate of Filter. | Kind of Sewage applied. |
|---|---|---|---|---|---|
| 135, . . . | June, 1902–Aug., 1903, | 47 | 0 | 2,142,000 | Strained. |
| 136, . . . | June, 1902–Aug., 1903, | 47 | 2 | 2,082,000 | Septic. |
| 189, . . . | June, 1902–Aug., 1903, | 43 | 60 | 2,338,500 | Untreated. |
| 135, . . . | Feb., 1904–Jan. 1, 1905, | 18 | 0 | 1,158,000 | Untreated. |
| 136, . . . | Feb., 1904–Jan. 1, 1905, | 18 | 0 | 1,951,000 | Untreated. |
| 222, . . . | Feb., 1904–Jan. 1, 1905, | 25 | 0 | 1,464,000 | Andover settled. |
| 233, . . . | Feb., 1904–Jan. 1, 1905, | 19 | 5 | 876,900 | Untreated. |
| 234, . . . | Feb., 1904–Jan. 1, 1905, | 19 | 42 | 953,200 | Untreated. |
| 235, . . . | Feb., 1904–Jan. 1, 1905, | 19 | 0 | 896,100 | Untreated. |
| 236, . . . | Feb., 1904–Jan. 1, 1905, | 19 | 47 | 905,900 | Untreated. |
| 247, . . . | Aug., 1904–Jan., 1905, | 5 | 60 | 897,800 | Untreated. |
| 248, . . . | Aug., 1904–Jan., 1905, | 5 | 0 | 943,000 | Untreated. |
| 135, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,459,000 | Untreated. |
| 136, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,883,000 | Untreated. |
| 233, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,149,000 | Untreated. |
| 235, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,147,000 | Untreated. |
| 247, . . . | May, 1906–Dec. 1, 1906, | 9 | 22 | 1,237,000 | Untreated. |
| 248, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,288,000 | Untreated. |

*Incubation Tests. — Contact Filters.*

| Filter No. | Period during which Incubations were made. | Number of Samples incubated. | Per Cent. of Samples which putrefied. | Average Rate of Filter. | Kind of Sewage applied. |
|---|---|---|---|---|---|
| 103, . . . | June, 1902–Aug., 1903, | 41 | 7 | 776,500 | Septic. |
| 137, . . . | June, 1902–Jan., 1903, | 14 | 77 | 722,200 | Untreated. |
| 175, . . . | June, 1902–Aug., 1903, | 34 | 6 | 596,200 | Strained. |
| 176, . . . | June, 1902–Aug., 1903, | 34 | 21 | 560,200 | Untreated. |
| 103, . . . | March–July, 1904, . | 6 | 17 | 97,900 | Septic. |
| 175, . . . | Feb. 1, 1904–Jan., 1905, | 16 | 19 | 466,600 | Strained. |
| 176, . . . | Feb. 1, 1904–Jan., 1905, | 16 | 31 | 459,400 | Untreated. |
| 221, . . . | Feb. 1, 1904–Jan., 1905, | 18 | 83 | 500,000 | Untreated. |
| 237, . . . | Feb. 1, 1904–Jan., 1905, | 38 | 24 | 845,500 | Effluent of Filter No. 221. |
| 251, . . . | Aug., 1904–Jan., 1905, | 6 | 83 | 585,400 | Septic. |
| 175, . . . | May, 1906–Dec. 1, 1906, | 8 | 0 | 490,700 | Strained. |
| 176, . . . | May, 1906–Dec. 1, 1906, | 8 | 0 | 483,500 | Untreated. |
| 221, . . . | May, 1906–Dec. 1, 1906, | 10 | 90 | 424,800 | Untreated. |
| 237, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 1,561,090 | Effluent of Filter No. 221. |
| 251, . . . | May, 1906–Dec. 1, 1906, | 10 | 0 | 726,500 | Septic. |

## Amount of Sludge discharged from the Andover Settling Tank during 1906.

During 1906, as during 1905, determinations were made as closely as possible of the amount of sludge deposited in the settling tank at the Andover filtration area, and from thence run upon sludge beds. According to these determinations, the weight of this wet sludge from April 23, when the winter's accumulation was taken from the sludge beds, until November 15, was 166,000 pounds. During this period the daily flow of sewage varied very greatly, volumes as low as 75,000 gallons and as high as 350,000 gallons per day being actually measured. Assuming, however, that the average daily flow during the period from April 23 to November 15 was 175,000 gallons, the figures show 83½ tons of wet sludge deposited, equal to .4 of a ton, or 800 pounds per day, — or 4,560 pounds of wet sludge per million gallons of sewage. On drying, this sludge loses 61 per cent. by weight, and according to these figures there was deposited during the year about 1,800 pounds of dry matter per million gallons of sewage flowing through the tank. Of this, 60 per cent. was organic matter, 33 per cent. carbon, 1.6 per cent. organic nitrogen and 24 per cent. fat and fatty matters, as shown by the table.

*Sewage Sludge discharged from the Andover Settling Tank.*

[Pounds.]

| 1906. | Wet Sludge. | Dry Sludge. | Loss on Ignition. | Kjeldahl Nitrogen. | Carbon. | Fats. |
|---|---|---|---|---|---|---|
| April 23, | 77,500 | 24,000 | 18,900 | 430 | 11,000 | 8,600 |
| May 14, | 35,500 | 14,200 | 7,600 | 190 | 4,400 | 2,500 |
| June 12, | 14,100 | 6,400 | 3,200 | 108 | 1,900 | 2,100 |
| July 12, | 17,200 | 7,400 | 3,500 | 104 | 2,000 | 1,600 |
| August 2, | 17,200 | 7,500 | 4,100 | 130 | 2,600 | 2,100 |
| September 12, | 33,400 | 16,000 | 7,200 | 215 | 2,500 | 2,000 |
| October 9, | 31,000 | 13,400 | 6,200 | 222 | 3,800 | 1,200 |
| October 30, | 19,600 | 8,500 | 5,300 | 176 | 3,200 | 1,800 |
| November 15, | 18,600 | 4,900 | 3,600 | 86 | 1,500 | 1,700 |
| Total, | 264,100 | 102,300 | 62,100 | 1,711 | 34,400 | 25,300 |
| Average per cent., | - | 39 | 60[1] | 1.64[1] | 33[1] | 24[1] |

[1] Dry sludge.

## Destruction of Sludge in Septic Tanks.

Beginning in 1898 and continuing up to the present time, various septic tanks have been operated at the station. The following summary of sludge destruction, or disappearance, is given to show what has been accomplished with Lawrence sewage, rather than to show what may be accomplished generally by such tanks, as different sewages give varying results.

These Lawrence analytical and measurement results seem to show that, of the matter deposited in the various septic tanks at the station, more than 80 per cent. of the volatile organic matter is passed into solution or given off as gas. This is from analytical data, but it is, of course, difficult to obtain entirely representative samples; and as at times gas evolution causes sediment to rise and pass from the tanks, much matter passes off in this way, as has frequently been noted in these reports, and this causes the figures showing sludge destruction to be greater than is actually the case. The analytical results show an apparent decomposition of much mineral matter, but this, of course, is due largely to passage of this matter from the tanks undetected.

The time of storage within the limits shown by the table and the strength of the sewage seem to have little influence on the per cent. of organic matter disappearing, or on the number of pounds of dry sludge disappearing per million gallons of sewage.

Septic Tanks B and F received concentrated sewage containing large amounts of suspended matter; Septic Tanks A, G and H, regular station sewage.

| | Per Cent. of Dry Sludge deposited in Tank, — disappearing. | Pounds of Dry Sludge disappearing per Million Gallons of Sewage. |
|---|---|---|
| Septic Tank A, 1898 to April, 1904, | 82 | 1,385 |
| April 1, 1904, to March 30, 1906, | 82 | 988 |
| Septic Tank B, | 74 | 877 |
| Septic Tank F, | 68 | 1,254 |
| Septic Tank G, | 89 | 786 |
| Septic Tank H, | 84 | 860 |

*Septic Tank A.*

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Entering Tank. | | Leaving Tank. | | Found in Tank. | |
| | | | Total. | Loss on Ignition. | Total. | Loss on Ignition. | Total. | Loss on Ignition. |
| 1898, | 23,600 | 42 | 40.5 | 29.6 | 10.6 | 7.9 | - | - |
| 1899, | 24,000 | 20 and 36 | 80.0 | 59.2 | 10.8 | 8.0 | - | - |
| 1900, | 62,000 | 17 and 21 | 205.0 | 150.0 | 43.4 | 32.4 | - | - |
| 1901, | 66,900 | 22 | 158.0 | 115.3 | 46.3 | 34.5 | - | - |
| 1902, | 59,500 | 14 | 115.0 | 88.2 | 53.0 | 39.1 | - | - |
| 1903, | 73,700 | 12 and 36 | 116.0 | 81.0 | 44.8 | 33.1 | - | - |
| Apr. 1, 1904,[1] | 19,200 | 24 | 42.2 | 28.8 | 13.6 | 10.3 | 94.4 | 45.8 |
| Total, | 329,600 | - | 756.7 | 552.0 | 222.5 | 165.3 | - | - |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, | 534.2 | 386.7 | 147.5 |
| Pounds disappearing in tank, | 439.8 | 340.9 | 98.9 |
| Per cent. disappearing in tank, | 82.0 | 88.0 | 67.0 |

[1] Tank emptied on this date.

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Entering Tank. | | Leaving Tank. | | Found in Tank. | |
| | | | Total. | Loss on Ignition. | Total. | Loss on Ignition. | Total. | Loss on Ignition. |
| Apr. 1-Dec. 31, 1904, | 79,800 | 12 and 36 | 154.9 | 107.6 | 41.8 | 33.2 | - | - |
| 1905, | 47,000 | 36 | 50.9 | 40.3 | 15.3 | 12.1 | - | - |
| Mar. 30, 1906, | 12,970 | 36 | 16.4 | 15.1 | 5.8 | 4.3 | 28.2 | 12.9 |
| Total, | 139,770 | - | 222.2 | 163.0 | 62.9 | 49.6 | - | - |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, | 159.3 | 113.4 | 45.9 |
| Pounds disappearing in tank, | 131.1 | 100.5 | 30.6 |
| Per cent. disappearing in tank, | 82.0 | 89.0 | 67.0 |

*Septic Tank B.*

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. — Entering Tank. — Total. | Entering Tank. — Loss on Ignition. | Leaving Tank. — Total. | Leaving Tank. — Loss on Ignition. | Found in Tank. — Total. | Found in Tank. — Loss on Ignition. |
|---|---|---|---|---|---|---|---|---|
| 1899, . . . . | 1,056 | 15 days, . | 7.9 | 5.8 | 0.7 | 0.4 | – | – |
| 1900, . . . . | 2,364 | 18-49 hours, | 27.8 | 20.1 | 4.6 | 3.2 | 4.4 | 2.3 |
| 1901, . . . . | 2,574 | 18-49 hours, | 50.2 | 36.7 | 9.9 | 6.2 | 18.1 | 9.5 |
| Total, . . | 5,994 | – | 85.9 | 62.6 | 15.2 | 9.8 | 9.8 | 9.5 |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, . . . . . . . | 70.7 | 52.8 | 17.9 |
| Pounds disappearing in tank, . . . . . . | 52.6 | 43.3 | 9.3 |
| Per cent. disappearing in tank, . . . . . | 74.0 | 82.0 | 52.0 |

*Septic Tank F.*

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. — Entering Tank. — Total. | Entering Tank. — Loss on Ignition. | Leaving Tank. — Total. | Leaving Tank. — Loss on Ignition. | Found in Tank. — Total. | Found in Tank. — Loss on Ignition. |
|---|---|---|---|---|---|---|---|---|
| 1904, . . . . . | 3,100 | 5 | 10.5 | 8.1 | 1.4 | 0.6 | – | – |
| 1905, . . . . . | 3,200 | 5 | 5.1 | 3.9 | 1.9 | 1.0 | – | – |
| October 1, 1906, . . | 2,710 | 5 | 6.3 | 4.8 | 2.0 | 1.2 | 5.3 | 3.4 |
| Total, . . . | 9,010 | – | 21.9 | 16.8 | 5.3 | 2.8 | – | – |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, . . . . . . . | 16.6 | 14.0 | 2.6 |
| Pounds disappearing in tank, . . . . . . | 11.3 | 10.6 | 0.7 |
| Per cent. disappearing in tank, . . . . . . | 68.0 | 76.0 | 27.0 |

*Septic Tank G.*

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. — Entering Tank. — Total. | Entering Tank. — Loss on Ignition. | Leaving Tank. — Total. | Leaving Tank. — Loss on Ignition. | Found in Tank. — Total. | Found in Tank. — Loss on Ignition. |
|---|---|---|---|---|---|---|---|---|
| 1904, . . . . . | 60,700 | 6 | 107.6 | 88.4 | 42.5 | 38.9 | – | – |
| 1905, . . . . . | 101,900 | 6 | 181.5 | 106.0 | 52.6 | 39.0 | 16.2 | 7.8 |
| Total, . . . | 162,600 | – | 289.1 | 194.4 | 95.1 | 77.9 | – | – |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, . . . . . . . | 144.0 | 116.5 | 27.5 |
| Pounds disappearing in tank, . . . . . . | 127.8 | 108.7 | 19.1 |
| Per cent. disappearing in tank, . . . . . | 89.0 | 93.0 | 69.0 |

*Septic Tank H.*

| Year. | Gallons applied. | Hours of Storage. | Pounds of Suspended Matter. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Entering Tank. | | Leaving Tank. | | Found in Tank. | |
| | | | Total. | Loss on Ignition. | Total. | Loss on Ignition. | Total. | Loss on Ignition. |
| 1904, | 21,000 | 18 | 33.2 | 29.2 | 9.4 | 5.9 | - | - |
| 1905, | 35,600 | 18 | 45.0 | 34.7 | 10.7 | 8.0 | 9.5 | 4.8 |
| Total, | 56,600 | - | 78.2 | 63.9 | 20.1 | 13.9 | - | - |

| | Total. | Loss on Ignition. | Fixed. |
|---|---|---|---|
| Pounds deposited in tank, | 58.1 | 50.9 | 7.2 |
| Pounds disappearing in tank, | 48.6 | 46.1 | 2.5 |
| Per cent. disappearing in tank, | 84.0 | 91.0 | 35.0 |

## Carbon in Sewage and Water.

During the year investigations were made in regard to the percentage of carbon in samples of water and sewage, in order to learn the relations existing between certain determinations, such as "loss on ignition," "oxygen consumed," and the actual amount of carbon or carbonaceous matters present in the samples examined.

It is well known that the "oxygen consumed" determination indicates only a portion of the carbon present in the water or sewage tested, and that that portion is not a constant; that the "loss on ignition" determination includes some mineral as well as the organic matter present. In this study six samples of sewage and four of the same sewage filtered, and two samples of water were evaporated, and analyses of the dry residues were made. The alkalinity in all the samples was neutralized, to avoid error due to decomposition of carbonates during combustion. Regular water analyses were also made of duplicates of each sample.

From the results of the examinations of the samples of the sewage, it was found that the carbon in the dry residue from evaporation varied from 35 to 57 per cent., with an average of 47.5 per cent. of the total loss on ignition; and it is a fact that most, if not all, of the compounds likely to be found in sewage have percentages of carbon varying between these limits. The carbohydrates have 40 to 44 per cent., the albuminous bodies 50 to 55 per cent., and fats separated from sewage, 62 per cent. of carbon.

The results, taken as a whole, showed that, while "loss on ignition" does not bear a very constant relation to the per cent. of carbon, it is undoubtedly a fair measure of the organic matter present.

The carbon in the filtered samples varied from 29 to 39 per cent., or an average of 35 per cent. of the loss on ignition. Further results showed that the figures given by "oxygen consumed" determinations represent from 10 to 20 per cent., with an average of 16 per cent. of the oxygen that would be actually required to oxidize all the carbon present. In the filtered samples the per cent. is higher and more constant (22 to 26 per cent.). Only about 22 per cent. of the "loss on ignition" of the dry residues from the evaporation of the samples of water was carbon, and the "oxygen consumed" was about 44 per cent. of the total oxygen that would have been required to oxidize this carbon. These figures show that the carbonaceous matter in the water examined was different in composition, or state of decomposition, from that in the sewage. The following figures show the "oxygen consumed" by some pure carbonaceous substances when certain definite weights are submitted to the "oxygen consumed" process: —

| | Oxygen consumed (Parts per 100,000). | Per Cent. which Oxygen consumed is of Oxygen required. |
|---|---|---|
| Saccharose, | 26,500 | 24.0 |
| Dextrose, | 24,000 | 22.0 |
| Starch, | 200 | 0.17 |
| Lactose, | 10,200 | 96.0 |
| Cellulose, | 156 | 0.18 |
| Peptone, | 7,400 | 5.7 |

These figures show that cellulose is only very slightly attacked by the permanganate during the "oxygen consumed" process. The sample of Lawrence street sewage, No. 2 (see table below), contained a considerable amount of finely divided paper, which accounts for the low ratio of 10 per cent. which the oxygen consumed was of the total oxygen required to oxidize the carbon present in this sample.

A series of tables here presented summarizes the results obtained in this work. The first table gives the results of the analyses of these samples of sewage, together with the results of the determinations of carbon and hydrogen in the residues; the second table shows the relation between the carbon and other constituents of sewage and between "oxygen consumed" figures, and the amount of oxygen actually required to oxidize the carbon present. The table shows that the carbon in these samples of sewage was from twelve to fifteen times as great as the organic nitrogen, and emphasizes the fact so frequently mentioned in these reports during the past two or three years, that, while analytical data in regard to sewage filtration are largely devoted to showing the nitrogen disposal efficiency of a filter, the chief labor of such filters is in

adequately disposing of the carbonaceous matters reaching them. The third table presents similar data in regard to the samples of water studied in this way.

*Carbon Studies.— Analyses of Samples of Sewage examined.*

[Parts per 100,000.]

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. |
|---|---|---|---|---|---|---|
| **Ammonia: —** | | | | | | |
| Free, | 4.70 | 4.20 | 2.70 | 6.70 | 4.20 | 2.20 |
| Total albuminoid, | 0.98 | - | - | 0.78 | 0.66 | 0.90 |
| Albuminoid in solution, | 0.51 | - | - | - | 0.40 | 0.61 |
| **Kjeldahl nitrogen: —** | | | | | | |
| Total, | 1.50 | 2.01 | 1.50 | 1.53 | 1.16 | 2.87 |
| In solution, | 0.80 | 1.01 | 0.61 | - | 0.59 | 2.25 |
| **Oxygen consumed: —** | | | | | | |
| Total, | 7.80 | 8.50 | 6.30 | 6.60 | 5.80 | 10.70 |
| In solution, | 4.60 | 5.05 | 3.45 | 4.60 | 3.70 | 8.90 |
| **Unfiltered solids: —** | | | | | | |
| Total, | 87.8 | 104.3 | 88.8 | 73.8 | 61.8 | 82.5 |
| Loss on ignition, | 39.0 | 56.7 | 36.8 | 36.6 | 25.8 | 42.5 |
| Fixed, | 48.8 | 47.6 | 52.0 | 37.2 | 36.0 | 40.0 |
| **Filtered solids: —** | | | | | | |
| Total, | 68.1 | 54.5 | 66.5 | 61.0 | 51.3 | 58.9 |
| Loss on ignition, | 21.6 | 20.8 | 14.8 | 24.0 | 17.9 | 22.5 |
| Fixed, | 46.5 | 33.7 | 51.7 | 37.0 | 33.4 | 36.4 |
| **Dry residue: —** | | | | | | |
| Per cent. carbon: — | | | | | | |
| Total, | 20.30 | 30.64 | 21.54 | 17.37 | 19.60 | 24.20 |
| In solution, | 10.54 | 14.84 | 8.46 | 11.26 | - | - |
| Per cent. hydrogen: — | | | | | | |
| Total, | 3.77 | 4.70 | 3.38 | 4.01 | 2.73 | 3.04 |
| In solution, | 2.64 | 2.73 | 1.92 | 2.08 | - | - |

*Carbon Studies.— Table showing Relation between Carbon and Other Constituents in Sewage and Oxygen consumed to Oxygen required.*

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. |
|---|---|---|---|---|---|---|
| **Per cent. which loss on ignition was of solids: —** | | | | | | |
| Total, | 44 | 54 | 41 | 50 | 42 | 52 |
| In solution, | 32 | 38 | 22 | 39 | 35 | 38 |
| **Per cent. which carbon was of loss on ignition: —** | | | | | | |
| Total, | 46 | 57 | 53 | 35 | 47 | 47 |
| In solution, | 33 | 39 | 38 | 29 | - | - |
| **Parts carbon: —** | | | | | | |
| Total, | 18 | 32 | 19 | 13 | 12 | 20 |
| In solution, | 7 | 8 | 6 | 7 | - | - |
| **Parts oxygen required to oxidize carbon: —** | | | | | | |
| Total, | 48 | 85 | 51 | 34 | 32 | 53 |
| In solution, | 19 | 21 | 16 | 18 | - | - |
| **Per cent. which oxygen consumed was of oxygen required to oxidize carbon: —** | | | | | | |
| Total, | 16 | 10 | 12 | 19 | 18 | 20 |
| In solution, | 24 | 24 | 22 | 26 | - | - |
| **Ratio of carbon to Kjeldahl nitrogen: —** | | | | | | |
| Total, | 12.0 | 15.9 | 12.7 | 8.4 | 10.4 | 7.0 |
| In solution, | 8.8 | 7.9 | 9.8 | - | - | - |
| **Ratio of carbon to total nitrogen (free ammonia nitrogen + Kjeldahl),** | 3.4 | 5.9 | 5.1 | 1.8 | 2.6 | 4.6 |

*Analyses of Two Samples of Water studied.*

[Parts per 100,000.]

| | Free Ammonia. | Total Albuminoid Ammonia. | Oxygen Consumed. | Solids. Total. | Solids. Loss on Ignition. | Solids. Fixed. | Dry Residue Per Cent. Carbon. |
|---|---|---|---|---|---|---|---|
| Canal water, | .0106 | .0166 | .70 | 7.2 | 2.5 | 4.7 | 7.90 |
| City water, | .0036 | .0144 | .45 | 7.0 | 1.9 | 5.1 | 5.80 |

| | Canal Water. | City Water. |
|---|---|---|
| Per cent. which loss on ignition was of total solids, | 35.0 | 27.0 |
| Per cent. which carbon was of loss on ignition, | 23.0 | 21.0 |
| Parts carbon, | 0.57 | 0.41 |
| Parts oxygen required to oxidize carbon, | 1.52 | 1.08 |
| Per cent. which oxygen consumed was of oxygen required to oxidize carbon, | 46.0 | 42.0 |

Further studies along this line were made with samples of sediment from the effluents of trickling and contact filters and of sludge from sewage, and the results are shown in a following table. In the samples of sewage sludge the ratio of carbon to the loss on ignition was fairly uniform, varying only from 52 to 61 per cent. A much larger variation occurred with the filter sediments, however, this undoubtedly being partly due to the bacterial working over that the sediment receives while passing through the filters, and partly to retention of certain matters in the filter; but the actual analytical results do not indicate the difference between putrescible sewage sludge and stable filter sediment that physical examinations and incubation tests show clearly.

*Carbon Studies.— Table of Sludge and Sediment Examinations, expressed in Percentages.*

| Sludge from Filter No. | 1906. | Per Cent. of Carbon Present. | Per Cent. Loss on Ignition. | Per Cent. Oxygen consumed on Dry Sludge. | Per Cent. Oxygen required to oxidize Carbon. | Per Cent. "Oxygen consumed" is of Oxygen required to oxidize Carbon. | Per Cent. Carbon is of Loss on Ignition. |
|---|---|---|---|---|---|---|---|
| 175, | Oct. 17, | 31.91 | 44.9 | 8.2 | 85.1 | 9.6 | 71.0 |
| 176, | Oct. 17, | 28.16 | 46.4 | 8.8 | 75.1 | 11.7 | 61.0 |
| 233, | Oct. 17, | 17.21 | 48.6 | 11.6 | 45.8 | 25.0 | 35.0 |
| 235, | Oct. 17, | 20.40 | 44.5 | 9.8 | 54.3 | 18.0 | 46.0 |
| 248, | Oct. 17, | 23.45 | 51.8 | 11.5 | 62.5 | 18.4 | 45.0 |
| Septic Tank G, inlet, | Jan. 3, | 30.84 | 50.4 | 13.9 | 82.2 | 16.9 | 61.0 |
| Septic Tank G, outlet, | Jan. 3, | 28.87 | 48.2 | 6.8 | 77.0 | 8.8 | 60.0 |
| Septic Tank H, inlet, | Jan. 3, | 28.62 | 50.2 | 15.1 | 76.3 | 19.8 | 57.0 |
| Septic Tank H, outlet, | Jan. 3, | 26.89 | 47.8 | 17.3 | 71.6 | 24.1 | 56.0 |
| Septic Tank A, inlet, | Apr. 1, | 28.11 | 48.8 | 9.6 | 74.9 | 12.8 | 58.0 |
| Septic Tank A, outlet, | Apr. 1, | 22.08 | 42.4 | 13.3 | 58.8 | 22.6 | 52.0 |

## A Study of the Rate of Filtration and Amount of Suspended Matter applied to Sand Filters as related to Volume of Sand removed.

In the operation of water filters the rate is maintained at as high a figure as possible compatible with efficient filtration; that is, efficient bacterial removal and the production of an effluent of satisfactory appearance. In doing this, it is expected that such filters will require the removal of a certain amount of sand from time to time, in order that a suitably high rate may be maintained. In sewage filtration, by the use of sand filters, it is generally intended so to operate them that sand removal shall be of very infrequent occurrence. It has been shown by the work at the station that a certain amount of stable organic and mineral matter will accumulate, however, and eventually necessitate sand removal; but it is possible to maintain such filters in operation for many years before such removal becomes necessary. Much is said of late in regard to higher rates of operation of sand sewage filters, and such higher rates are, of course, possible, if sand is removed more frequently and less perfect purification is accepted. It is manifestly absurd, however, to state, after one or two years' operation at a high rate, that these rates can be easily maintained. A longer period of study is necessary.

During the past eight years and more, especially during the past three years, certain sand filters at the station have been operated at high rates, and careful records kept showing the amount of sand removal that is necessary to maintain these rates, and to show also the relation between sand removal and the amount of matter in suspension in the applied sewage. These figures are presented in following tables, together with similar figures from the operation of water filters.

In 1898, Filter No. 100 was put into operation and is still continued. The average rate of operation of this filter up to the time of the last sand removal was 250,000 gallons per acre daily, and it has been possible to maintain this rate as the filter has received septic sewage containing much less suspended matter than regular station sewage. To maintain this average rate, however, with this septic sewage, it has been necessary to remove clogged sand from the filter several times, and the amount removed per million gallons of sewage filtered has increased as the age of the filter and depth of accumulation of organic matter have increased.

During the first four years of operation the sand removed amounted to 2.93 cubic yards per million gallons filtered, and during the following three years to 3.76 cubic yards per million gallons filtered. Filters Nos. 224 and 249, receiving the settled effluents of trickling filters and operated at rates varying from 600,000 to 800,000 gallons per acre

daily, have given similar results, as shown in the tables following. In the tables are also given figures showing the pounds of suspended matter applied per cubic yard of sand removed, and the proportion of this that is organic suspended matter. Two tables showing the sewage filter results are presented, the first showing the quantity of sewage applied in million gallons per acre between each scraping or sand removal, the depth of sand removed, the cubic yards removed per acre and per million gallons filtered, and the estimated pounds of matter in suspension in the applied sewage per cubic yard of sand removed; while the second table presents the rate of operation of each filter in million gallons per acre daily, the number of times sand was removed, the pounds of suspended matter applied with each million gallons, the pounds in each cubic yard of sand removed and pounds per acre per scraping.

It is especially noticeable, in comparing Filters Nos. 100, 224 and 249, that, as would be expected, as the rate maintained is increased, the amount of suspended matter that can accumulate in the sand, and still allow this high rate, decreases rapidly. On this second table some similar figures gathered from the operation of the Lawrence city filter and Filter No. 8B at the experiment station, both filtering river water, are given. They are of interest as showing how the higher rates maintained with these water filters allow still less accumulation of matter before scraping is necessary. The city filter is not completely underdrained, while Filter No. 8B is entirely underdrained; and the differing resistance of each to the passage of water, owing to this difference of construction, is clearly shown by the different accumulation of suspended matter that can occur before scraping becomes necessary.

*Comparisons of Rate, Sand Removal and Accumulation of Matters applied in Suspension in Sewage. — Filters Nos. 100, 224 and 249.*

*Filter No. 100.*

| Period of Operation. | Quantity of Sewage applied (Million Gallons per Acre). | Depth of Sand removed (Inches). | Cubic Yards of Sand removed. | | Estimated Pounds of Matter in Suspension applied per Cubic Yard of Sand removed. | | |
|---|---|---|---|---|---|---|---|
| | | | Per Acre. | Per Million Gallons filtered. | Total Solids. | Organic Matter from Loss on Ignition. | Kjeldahl Nitrogen. |
| Jan. 1, 1898, Nov. 8, 1901, | 275.5 | 6 | 807 | 2.93 | 256.4 | 136.7 | 7.00 |
| Nov. 9, 1901, Apr. 6, 1904, | 214.0 | 6 | 807 | 3.76 | 232.4 | 123.9 | 6.34 |

*Filter No. 224.*

| Period of Operation. | Quantity of Sewage applied (Million Gallons per Acre). | Depth of Sand removed (Inches). | Per Acre. | Per Million Gallons filtered. | Total Solids. | Organic Matter from Loss on Ignition. | Kjeldahl Nitrogen. |
|---|---|---|---|---|---|---|---|
| Oct. 1, 1903, Dec. 31, 1904, | 270.4 | 3 | 403 | 1.49 | 125.5 | 71.9 | 3.03 |
| Jan. 1, 1905, Dec. 16, 1905, | 132.4 | 6 | 807 | 6.10 | 20.1 | 10.7 | 0.49 |

*Comparisons of Rate, Sand Removal and Accumulation of Matters applied in Suspension in Sewage, etc.* — Concluded.

*Filter No. 249.*

| Period of Operation. | Quantity of Sewage applied (Million Gallons per Acre). | Depth of Sand removed (Inches). | Cubic Yards of Sand removed. | | Estimated Pounds of Matter in Suspension applied per Cubic Yard of Sand removed. | | |
|---|---|---|---|---|---|---|---|
| | | | Per Acre. | Per Million Gallons filtered. | Total Solids. | Organic Matter from Loss on Ignition. | Kjeldahl Nitrogen. |
| May 16, 1904, to Feb. 1, 1904, | 158.3 | 3 | 403 | 2.54 | 97.6 | 52.1 | 2.86 |
| Feb. 2, 1905, to May 24, 1905, | 66.4 | 1 | 134 | 2.02 | 60.4 | 32.2 | 1.48 |
| May 25, 1905, to Jan. 31, 1906, | 132.8 | 3 | 403 | 3.04 | 41.8 | 22.3 | 0.99 |
| Feb. 1, 1906, to Aug. 6, 1906, | 116.9 | 3 | 403 | 3.45 | 89.8 | 45.7 | 2.17 |

*Comparison of Sand Removal and Amount of Suspended Matter applied.* — *Sewage Filters Nos. 100, 224 and 249 and Water Filter No. 8B and City Filter.*

| Period of Operation. | Rate Million Gallons per Acre daily. | Times Sand removed. | Cubic Yards Sand removed per Million Gallons filtered. | Pounds of Suspended Matter applied. | | |
|---|---|---|---|---|---|---|
| | | | | Per Million Gallons filtered. | Per Cubic Yard Sand removed. | Per Acre per Scraping. |
| City filter, 1896–1905 (10 years), . . | 1.240 | 134 | 1.97 | 14.45 | 7.32 | 1,223 |
| Filter 8B, May 24, 1901, to April 9, 1906 (4 years, 320 days). | 3.140 | 70 | 0.57 | 12.96 | 22.38 | 490 |
| Filter 100, Jan. 1, 1898, to April 6, 1904 (6 years, 97 days). | 0.248 | 2 | 2.85 | 804.59 | 244.40 | 197,125 |
| Filter 224, Oct. 1, 1903, to Dec. 16, 1905 (2 years, 78 days). | 0.571 | 2 | 3.00 | 165.97 | 55.25 | 33,427 |
| Filter 249, May 16, 1904, to Aug. 6, 1906 (2 years, 46 days). | 0.706 | 4 | 2.89 | 212.04 | 74.90 | 25,148 |

## Determination of Carbon Dioxide in Effluents.

The amount of free and half-bound carbon dioxide was determined twice during the year in all sewage filter effluents. Effluents which were acid contained the greatest amount of free carbon dioxide, and of course no half-bound carbon dioxide. All the sand sewage filters, except No. 249, gave effluents acid to phenol-phthalein almost continuously; but sand Filter No. 5C, started in July, 1905, gave an acid effluent only once during the first nine months of operation, although nitrifying actively. After that there was not enough available alkali in the sand to neutralize the excess of nitric acid over that combining with the alkalinity of the applied sewage. The results of these determinations follow: —

*Parts Carbon Dioxide in Effluents.*

| Filter No. | Aug. 2, 1906. | | Aug. 17, 1906. | |
|---|---|---|---|---|
| | Free Carbon Dioxide. | Half-bound Carbon Dioxide. | Free Carbon Dioxide. | Half-bound Carbon Dioxide. |
| 1, | 24.2 | 0.0 | 10.4 | 0.0 |
| 2, | 23.0 | 0.0 | 12.4 | 0.0 |
| 4, | 17.6 | 0.0 | 11.2 | 0.0 |
| 5, | 9.9 | 0.0 | 4.6 | 0.0 |
| 6, | 16.2 | 0.0 | 9.7 | 0.0 |
| 9, | 11.6 | 0.0 | 7.7 | 0.0 |
| 10, | 5.8 | 0.0 | 5.7 | 0.0 |
| 100, | 13.1 | 0.0 | 9.9 | 0.0 |
| 135, | 2.6 | 0.4 | 2.8 | 2.5 |
| 136, | 8.1 | 3.6 | 5.9 | 3.8 |
| 175, | 8.8 | 3.2 | 13.7 | 2.1 |
| 176, | 9.5 | 6.2 | 12.9 | 5.9 |
| 221, | 13.5 | 10.4 | 14.5 | 9.4 |
| 224, | 4.7 | 0.0 | 3.5 | 0.0 |
| 233, | 5.5 | 3.9 | 4.0 | 3.9 |
| 235, | 7.8 | 3.9 | 7.9 | 2.0 |
| 237, | 5.5 | 3.4 | 4.7 | 3.0 |
| 242, | 12.1 | 0.0 | 8.4 | 1.2 |
| 247, | 8.4 | 2.6 | 5.0 | 6.7 |
| 248, | 1.5 | 3.6 | 2.9 | 5.0 |
| 249, | 5.4 | 0.4 | 4.4 | 0.3 |
| 249 (applied), | 1.3 | 2.0 | - | - |
| 250, | 4.7 | 0.0 | 3.5 | 0.0 |
| 251, | 9.8 | 4.9 | 10.5 | 6.4 |

## Alkalinity and Acidity of Sewage Filter Effluents.

Following the work of last year upon this subject, determinations were made to show the variation in acidity and alkalinity of the effluents of different sewage filters operating under differing conditions. The average results of monthly determinations are given in following tables. As stated in the last report, acid effluents are produced by filters giving the most thorough purification. Of the filters tested Nos. 1, 2, 4, 5C, 6, 9A, 10, 100, 224, 249, 250, 305, 306, 312, 313, 314, 315 and 316 are sand filters; Nos. 175, 176, 221, 237, 251 and 252 are contact filters, while the remainder are trickling filters.

*Average Alkalinity of Effluents of Sewage Filters.*

[Parts per 100,000.]

| | Filter Number. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 4. | 5C. | 6. | 9A. | 10. | 100. | 125. |
| Alkalinity, . . . | -2.1 | -1.3 | -1.2 | -0.3 | -1.4 | -1.9 | -1.2 | -0.6 | 2.0 |

*Average Alkalinity of Effluents of Sewage Filters* — Continued.

[Parts per 100,000.]

| | Filter Number. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 126. | 175. | 176. | 221. | 222. | 224. | 223. | 225. | 227. |
| Alkalinity, . . . | 4.0 | 5.6 | 11.6 | 17.1 | 13.6 | -0.5 | 6.7 | 4.9 | 6.6 |

*Average Alkalinity of Effluents of Sewage Filters* — Continued.

[Parts per 100,000.]

| | Filter Number. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 242. | 247. | 248. | 249. | 250. | 251. | 252. | 249[1] and 250.[1] |
| Alkalinity, . . . | -0.7 | 15.2 | 8.6 | 0.3 | -0.4 | 11.4 | 0.5 | 6.5 |

*Average Alkalinity of Effluents of Sewage Filters* — Concluded.

[Parts per 100,000.]

| | Filter Number. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 252.[1] | 305. | 306. | 312. | 313. | 314. | 315. | 316. |
| Alkalinity, . . . | 2.9 | 1.3 | 1.4 | 1.4 | 3.5 | 3.9 | 4.2 | 2.0 |

[1] Applied sewage.

## Mechanical Filtration of the Effluents of Trickling Filters.

Beginning in April and continuing throughout the remainder of the year, experiments were carried on upon the purification of the effluents of trickling filters with the aid of coagulants and rapid filtration through a mechanical filter. The rate of filtration followed varied from 25,000,000 to 50,000,000 gallons per acre daily. The detailed results of this work are given below. (See page 283.)

## Purification of Factory Wastes.

Throughout the year experiments were made upon filters operated with the wastes from woolen mills, paper mills, shoddy mills, bleaching and dye works, etc., and the results of this work are presented below.

## Studies of Methods of Application of Sewage to Trickling Filters.

During the year various methods of applying sewage to trickling filters so as to obtain the best distribution were studied. While a full account of these methods is not given in this report, especial attention is called to the description of Filter No. 222 (page 267), and of a quite successful method devised at the station.

With most of the jet sprinklers proposed to be operated with a constant head, the greater portion of the sewage falls in a ring and a large portion of the surface receives no sewage. Furthermore, with such a system the rate at which the filter is operated is dependent entirely upon the size of the orifice and the acting head. By the use of an automatic flush tank, such as that installed at the experimental filter at Andover, the spray from the outlet is made to cover a gradually reducing circle as the head becomes less, and the whole surface within a given circle is sprinkled. Furthermore, as the flush tank operates intermittently, the rate of operation of the filter is controlled by the flow of sewage entering the flush tank, and is independent of head or size of orifice, and at low rates the filter receives the same volume per dose as when operating at a high rate; but the dose is applied less frequently, the volume of sewage applied at one time depending upon the capacity of the flush tank.

Experiments are in progress to study the proportional distribution of sewage over the sprinkled area, when operating with sprinkler nozzles of different types and with dash plates of different sizes and types, and also to determine the effect of placing nozzles and dash plates at different distances from the surface of the filter, the effect of different heads, and the effect of variations in the size of the orifices through which the sewage is made to pass. In addition, the distributing effect of different depths of filtering material is to be investigated.

In the experiments the sewage is placed in a galvanized-iron tank, fastened to a platform which slides up and down upon fixed guides, to which it may be securely fastened at any elevation. The outlet of the tank is at the bottom, from which the sewage is led through a shut-off and appropriate piping to any type of sprinkler which we may wish to study. A number of types of jet sprinklers, such as those proposed for

the Columbus, O., sprinkling filters, and those used on certain of the trickling filters in England, have been obtained, and also a supply of dash plates of different shapes and dimensions, and a sliding standard upon which these dash plates may be fixed at any distance above the filter surface. The distance between the face of the dash plate or the orifice of a sprinkler nozzle has been termed the "riser distance." Placed radially at definite distances from the dash plate are a series of bottles containing tunnels of definite area, in which the flow of sewage is caught and measured. The procedure has been to fill the feed tank to a given depth, open the outlet and allow the sewage to flow through the pipes to a choked outlet, when it impinges upon a dash plate and is thrown out in the form of an umbrella, breaking on the outer edge into a fine spray. Measurements of the fall of sewage are made in each of the four quadrants of the circular area sprinkled, and measurements are made only when there is no wind. The operating head has varied between 6 inches and 54 inches, the choked orifice through which the sewage flows being 4 inches long and the distance from the orifice to the dash plate being 1 inch in each case. Orifices having a diameter of ¼ inch, ⅜ inch, ½ inch, ¾ inch and 1 inch have been used with each combination of head, riser distance and dash plate. The dash plates studied have been a flat plate, circular in area and 2 inches in diameter, a circular flat plate 2 inches in diameter having the outer quarter-inch turned up at an angle of 45 degrees, called for convenience a 2-inch dished plate, and a similar plate 3 inches in diameter, designated a 3-inch dished plate. These plates have been placed 12 inches above the filter surface in each case, and the 2-inch dished plate has also been used with a riser distance of 6 inches. The results of the experiments so far completed are so few that any conclusions must be subject to revision. They may be briefly summed up as follows: —

*Area Wet.* — The outside limit of the sprinkled area is considered to be that portion where the quantity of sewage falling upon the unit area was less than ½ of 1 per cent. of the proportionate part of the whole dose for that area. On this basis, circles from 30 to 66 inches in diameter were wet by the 2-inch dished plate with different orifices and a 6-inch riser, and from 54 to 72 inches in diameter by the same plate with a 12-inch riser. The area wet by the 2-inch flat plate was considerably less than that by the dished plate, varying from 36 to 54 inches with the various orifices. The area wet by the 3-inch dished plate was intermediate between that for the 2-inch flat plate and the 2-inch dished plate.

*Size of Orifice.* — The area wet was greatest when an orifice ⅜ inch in diameter was used, and least when a 1-inch orifice was used. The

distribution curves were somewhat flatter, however, with the larger orifices.

*Distribution.* — The distribution in all four quadrants of the circle was never the same, often varying as much as 50 per cent. in the extremes. With the 2-inch dished plate placed 6 inches above the filter surface, 80 to 90 per cent. of the sewage was spread upon from 21 to 38 per cent. of the surface wet. With the same dished plate and a 12-inch riser distance, 75 to 85 per cent. of the sewage was concentrated upon 21 to 34 per cent. of the wet area. With the 2-inch flat plate 12 inches above the ground, 70 to 90 per cent. of the sewage was concentrated upon 30 to 44 per cent. of the surface, and with the 3-inch dished plate, 80 to 95 per cent. of the sewage was concentrated upon 30 to 55 per cent. of the surface. As a rule, no part of the surface received the theoretical amount of sewage, although in a few cases from 10 to 20 per cent. of the surface received within 10 per cent. of the theoretical amount.

## Large Sand Filters in Operation at the Station.

### *Filters Nos. 1 to 10, inclusive, and Filters Nos. 305 and 306.*

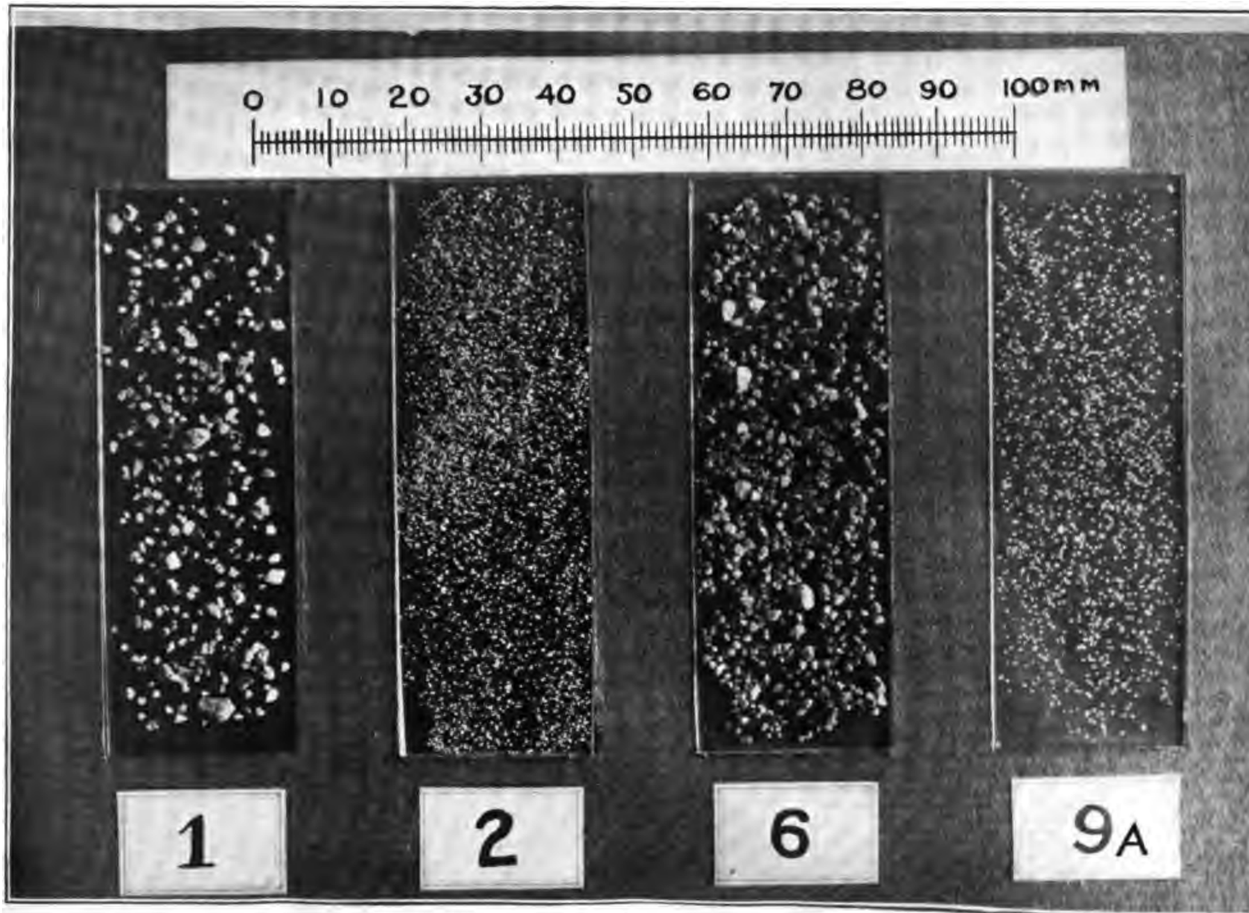
During the year the large sand filters were continued in operation, and two new filters added, namely, Nos. 305 and 306. All of these out-door sand filters were protected to a certain extent from the winter weather, as noted in the last report, and this protection is about equal to that given by ice and snow on the municipal filters.

## Studies of Rates of Filtration with Sand Filters, and Effect of Depth of Filtering Material.

### *Filters Nos. 312, 313, 314, 315 and 316.*

Five new filters, each 1/20000 of an acre in area and constructed of sand of an effective size of 0.25 millimeter, were put into operation Oct. 1, 1906, to study comparatively the purification of sewage on sand filters operated at different rates, the effect of mode of application of sewage and the effect of doubling the depth of filtering material.

Filters Nos. 312, 313, 314 and 315, each contained 5 feet of sand and Filter No. 316 contained 10 feet of sand. Sewage was applied to Filter No. 312 at a rate of 50,000 gallons, to Filters Nos. 313 and 316 at a rate of 100,000 gallons and to Filters Nos. 314 and 315 at a rate of 150,000 gallons per acre daily. The sewage applied to Filter No. 315 was divided into six doses, applied at intervals two hours apart, the sewage for each of the other filters being applied in one dose.




SAND.—FILTERS NOS. 1, 2, 6 AND 9A.

## Large Sand Filters in Operation at the Station. — Filters Nos. 1 to 10, inclusive.

### *Filter No. 1.*

Filter No. 1, constructed of 60 inches in depth of sand of an effective size of 0.48 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Jan. 10, 1888. The filter was operated at a rate of 60,000 gallons per acre daily for six days per week from Dec. 1, 1905, to May 8, 1906; at a rate of 50,000 gallons from May 9 to September 15, and at a rate of 60,000 gallons per acre daily from September 20 to November 30. From December 1 to March 8, the surface of the filter was trenched and the trenches were covered with boards. On March 9, the board covers were removed and the sand in the trenches was raked 3 inches deep. On April 16, the sand in the trenches was raked 3 inches deep and the surface of the filter was levelled. July 2, the surface was again trenched in the same manner as during the winter, but with the trenches at right angles to the winter trenching. On July 29, the sand in the trenches was raked 3 inches deep and the surface again levelled. On September 15, the surface was dug over 8 to 10 inches deep, and the filter was allowed to rest until September 20. On November 10, the surface was again trenched. That portion of the surface to which sewage was applied was raked 1 inch deep thirty-three times during the year, as follows: during December, twice; January, once; March, twice; April, four times; May, four times; June, four times; July, three times; August, four times; September, twice; October, four times; and November, three times.

### *Filter No. 2.*

Filter No. 2, constructed of 60 inches in depth of fine sand of an effective size of 0.08 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of these trenches being below the surface of the remainder of the filter, and to them the sewage was applied at the rate of 40,000 gallons per acre daily from Dec. 1, 1905, to May 8, 1906; at the rate of 30,000 gallons per acre daily from May 9 to September 14; and at the rate of 40,000 gallons per acre daily from September 20 to November 30. During the winter, the trenches were covered with boards. On March 9, these board covers were removed and the trenches were raked 3 inches deep. On April 21, the trenches were dug over 6 inches deep. On June 12, the grass and weeds growing on the filter were cut. On July 2, all the grass and weeds were removed and the trenches were dug over 12 inches

deep. On August 10, the grass and weeds were again cut. On September 15, the trenches were again dug over 8 to 10 inches deep and the filter rested until September 20. On November 10, the trenches were again dug over to a depth of 6 inches. That portion of the surface to which sewage was applied was raked 1 inch deep thirty-one times during the year, as follows: during December, twice; January, once; February, once; March, twice; April, twice; May, four times; June, four times; July, four times; August, four times; October, four times; and November, three times.

### *Filter No. 4.*

Filter No. 4, constructed of 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Dec. 19, 1897. The surface of the filter is arranged with circular trenches about 14 inches wide and 12 inches deep of coarse sand of an effective size of 0.48 millimeter, the surface of these trenches being below the remainder of the filter, and to them the sewage was applied at the rate of 40,000 gallons per acre three times a week throughout the year. During the winter, the trenches were covered with boards. On March 9, the board covers were removed and the surface of the trenches was raked 3 inches deep. On April 12, the trenches were dug over 6 inches deep; on July 2, 12 inches deep; on September 15, 8 to 10 inches deep; and on November 10, 6 inches deep. On June 12 and August 10, the grass and weeds growing on the ridges were cut, and on July 2 all the grass and weeds growing on the filter were removed. That portion of the surface of the filter to which sewage was applied was raked 1 inch deep thirty-four times during the year, as follows: during December, twice; January, once; February, once; March, twice; April, twice; May, four times; June, four times; July, four times; August, four times; September, three times; October, four times; and November, three times.

### *Filter No. 5C.*

Filter No. 5C is $\frac{1}{200}$ of an acre in area, and is constructed of 60 inches in depth of sand of an effective size of 0.22 millimeter, and was first put into operation on July 20, 1905. Sewage was applied at the rate of 60,000 gallons per acre daily from Dec. 1, 1905, to May 8, 1906, and from May 9 to November 30 at the rate of 50,000 gallons per acre daily. During the winter, the surface of the filter was trenched and the trenches were covered with boards. On March 9, the board covers were removed and the sand in the trenches raked 3 inches deep. On April 21, the trenches were again raked 3 inches deep, the surface of the filter levelled and then dug over to a depth of 6 inches. On

November 10, the surface of the filter was again trenched in the same manner as during the preceding winter. That portion of the surface of the filter to which sewage was applied was raked 1 inch deep thirty-five times during the year, as follows: during December, twice; January, once; February, once; March, twice; April, twice; May, four times; June, four times; July, four times; August, four times; September, four times; October, four times; and November, three times.

### *Filter No. 6.*

Filter No. 6, $\frac{1}{200}$ of an acre in area, is constructed of 44 inches in depth of mixed fine and coarse sand of an effective size of 0.35 millimeter, and was first put into operation on Jan. 12, 1888. Sewage was applied six times a week at the rate of 60,000 gallons per acre from Dec. 1, 1905, to May 8, 1906; at the rate of 50,000 gallons from May 9 to September 19; and at the rate of 60,000 gallons per acre from September 20 to November 30. During the winter, the surface of the filter was trenched and the trenches were covered with boards. On March 9, the board covers were removed and the trenches raked 3 inches deep. On April 16, the trenches were again raked 3 inches deep and the surface of the filter was levelled, and the whole filter then dug over to a depth of 6 inches. On July 2, the surface of the filter was again trenched, with the trenches arranged at right angles to those of the preceding winter. On July 29, the trenches were raked 3 inches deep and the surface of the filter again levelled. On September 15, the surface was dug over 8 to 10 inches deep, and the filter rested until September 20. On November 10, the surface was trenched in the same manner as during the preceding winter. On April 17 and 18, and from May 29 to June 1, inclusive, the filter was out of operation on account of high water in the river. That portion of the surface of the filter to which sewage was applied was raked 1 inch deep thirty-five times during the year, as follows: during December, three times; January, once; February, once; March, twice; April, three times; May, four times; June, four times; July, three times; August, four times; September, three times; October, four times; and November, three times.

### *Filter No. 9A.*

Filter No. 9A, $\frac{1}{200}$ of an acre in area, is constructed of 5 feet in depth of sand of an effective size of 0.17 millimeter, and was first put into operation on Nov. 18, 1890. Sewage was applied at the rate of 60,000 gallons per acre six times a week from Dec. 1, 1905, to May 8, 1906; at the rate of 50,000 gallons from May 9 to September 19; and at the rate of 60,000 gallons from September 20 to November 30. During the winter, the surface was trenched and the trenches were covered with boards. On

March 9, the board covers were removed and the trenches raked 3 inches deep. On April 16, the trenches were again raked 3 inches deep, the surface of the filter levelled and then dug over to a depth of 6 inches. On July 2, the surface was again arranged in trenches, with the trenches at right angles to those of the preceding winter. On July 29, the trenches were raked 3 inches deep and the surface of the filter levelled. On September 15, the surface was dug over 8 to 10 inches deep, and the filter allowed to rest until September 20. On November 10, the surface was again trenched for the winter. April 17 to 19 and May 29 to June 1, the experiment was interrupted by high water in the river. That portion of the surface of the filter to which sewage was applied was raked to a depth of 1 inch thirty-four times during the year, as follows: during December, twice; January, once; February, once; March, twice; April, three times; May, four times; June, four times; July, three times; August, four times; September, three times; October, four times; and November, three times.

*Filter No. 10.*

Filter No. 10, $\frac{1}{200}$ of an acre in area, is constructed of 5 feet in depth of fine and coarse mixed sand of an effective size of 0.35 millimeter, and was first put into operation on July 18, 1894. No underdrains are beneath the sand, except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface which is farthest from the underdrains from the remainder of the surface. To this quarter, the sewage is applied, and over the remainder of the surface is a layer of loam 8 inches in depth. Sewage was applied at the rate of 25,000 gallons per acre six times a week from Dec. 1, 1905, throughout the year. On March 11, the surface of the filter was raked to a depth of 3 inches, and was dug over on April 16 to a depth of 6 inches; on July 2, to a depth of 1 foot; on July 15, to a depth of from 8 to 10 inches; and on November 10, to a depth of 6 inches. After digging over the surface on September 15, the filter was allowed to rest until September 20. The experiment was interrupted by high water in the river April 17 to 19 and May 29 to June 1. That portion of the surface to which sewage was applied was raked to a depth of 1 inch thirty-eight times during the year, as follows: during December, four times; January, three times; March, once; April, four times; May, four times; June, four times; July, four times; August, four times; September, three times; October, four times; and November, three times. In December, 8 inches of snow was removed; in January, $\frac{1}{8}$ inch of ice; in February, $10\frac{1}{2}$ inches of snow; and in March, 29 inches of snow.

### *Filters Nos. 305 and 306.*

On August 24, 1906, two new filters, situated out of doors, semicircular in section, each containing 54 inches of sand of an effective size of 0.27 millimeter and having an approximate area of $\frac{1}{400}$ of an acre were put into operation. It is intended that these filters shall always be operated at the same rate and in the same manner, Filter No. 305 receiving the strong station sewage and Filter No. 306 receiving sewage diluted with canal water, in order to study the relative purification of sewage of different strengths. During the three months which these filters have been in operation, sewage has been applied to each at a rate of 60,000 gallons per acre six days each week, the sewage applied to Filter No. 306 being composed of equal parts regular sewage and canal water. On November 10, four trenches, 12 inches wide and 3 inches deep, were made in the surface of each filter, the sand removed from the trenches being piled upon the ridges. The surface of each filter was raked four times during the months of September, October and November.

### *Effluent of Filter No. 1.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Length of Time Sewage remained on Surface. | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** December, | 60,000 | 62 | 44 | 1h. 56m. | 0.9 | .38 | 1.4438 | .0710 | .1402 | 6.48 | 2.78 | .0160 | .77 | 14,500 |
| **1906.** January, | 62,200 | 62 | 43 | 50m. | 0.4 | .28 | 1.0025 | .0630 | .0982 | 5.20 | 3.04 | .0120 | .58 | 7,550 |
| February, | 57,500 | 57 | 42 | 1h. 4m. | 0.5 | .28 | 0.7333 | .0687 | - | 5.43 | 2.85 | .0113 | .57 | 8,300 |
| March, | 60,000 | 56 | 41 | 26m. | 0.3 | .25 | 0.9475 | .0643 | .1087 | 6.63 | 2.77 | .0060 | .52 | 3,350 |
| April, | 57,600 | 56 | 45 | 11m. | 0.1 | .21 | 0.5750 | .0585 | .0865 | 8.35 | 3.75 | .0135 | .56 | 6,200 |
| May, | 52,600 | 58 | 55 | 3m. | 0.1 | .21 | 0.1717 | .0590 | - | 17.27 | 6.52 | .0020 | .58 | 2,000 |
| June, | 46,200 | 61 | 61 | 3m. | 0 | .17 | 0.0808 | .0848 | - | 15.95 | 6.13 | .0000 | .43 | 650 |
| July, | 46,200 | 69 | 68 | 7m. | 0.5 | .21 | 0.2480 | .0567 | - | 17.30 | 4.82 | .0020 | .54 | 4,700 |
| August, | 50,000 | 73 | 74 | 3m. | 0 | .20 | 0.0474 | .0855 | - | 16.03 | 5.61 | .0006 | .43 | 1,970 |
| September, | 39,600 | 69 | 71 | 2m. | 0.1 | .15 | 0.0748 | .0827 | - | 15.97 | 5.55 | .0007 | .36 | 2,300 |
| October, | 60,000 | 60 | 61 | 5m. | 0.4 | .25 | 0.5000 | .0550 | - | 15.10 | 5.20 | .0019 | .58 | 4,000 |
| November, | 57,700 | 61 | 52 | 20m. | 1.3 | .34 | 0.9050 | .0910 | - | 14.80 | 2.48 | .0011 | .82 | 6,100 |
| Average, | 54,100 | 62 | 55 | 26m. | 0.4 | .24 | 0.5566 | .0567 | .1084 | 12.04 | 4.29 | .0056 | .56 | 5,100 |

## *Effluent of Filter No. 2.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Length of Time Sewage remained on Surface. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, . | 40,000 | 58 | 43 | 47m. | 0 | .10 | 0.5286 | .0264 | .0444 | 6.03 | 2.75 | .0950 | .17 | 225 |
| **1906.** January, . | 40,000 | 58 | 42 | 1h. 12m. | 0 | .11 | 0.4025 | .0350 | - | 4.95 | 2.49 | .0500 | .22 | 625 |
| February, . | 40,000 | 56 | 41 | 1h. 18m. | 0 | .11 | 0.4400 | .0300 | - | 5.53 | 2.96 | .0620 | .14 | 53 |
| March, . . | 40,000 | 56 | 40 | 32m. | 0 | .10 | 0.2403 | .0244 | .0424 | 5.68 | 2.66 | .0270 | .26 | 113 |
| April, . . | 38,400 | 56 | 45 | 18m. | 0 | .11 | 0.4025 | .0305 | - | 7.25 | 3.85 | .0565 | .21 | 63 |
| May, . . | 32,600 | 58 | 52 | 8m. | 0 | .10 | 0.0611 | .0233 | - | 12.57 | 5.24 | .0013 | .34 | 31 |
| June, . . | 27,700 | 61 | 59 | 4m. | 0 | .12 | 0.1360 | .0314 | - | 13.90 | 6.47 | .0001 | .37 | 78 |
| July, . . | 27,700 | 69 | 65 | 5m. | 0 | .14 | 0.0202 | .0257 | - | 13.33 | 6.01 | .0000 | .35 | 448 |
| August, . | 30,000 | 78 | 72 | 2m. | 0 | .12 | 0.0050 | .0226 | - | 14.57 | 5.78 | .0000 | .30 | 93 |
| September, . | 25,200 | 69 | 69 | 2m. | 0 | .11 | 0.0032 | .0225 | - | 16.13 | 5.29 | .0000 | .27 | 90 |
| October, . | 40,000 | 60 | 61 | 8m. | 0 | .12 | 0.0040 | .0214 | - | 13.60 | 5.24 | .0000 | .22 | 70 |
| November, . | 38,500 | 61 | 53 | 14m. | 0 | .10 | 0.1423 | .0222 | - | 12.60 | 4.79 | .0029 | .25 | 150 |
| Average, . | 35,000 | 61 | 54 | 24m. | 0 | .11 | 0.1988 | .0263 | .0434 | 10.51 | 4.46 | .0246 | .26 | 170 |

## *Effluent of Filter No. 4.*

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Length of Time Sewage remained on Surface. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, . | 20,000 | 58 | 43 | 18m. | 0 | .06 | 0.0659 | .0101 | - | 6.83 | 2.59 | .0062 | .11 | 175 |
| **1905.** January, . | 19,300 | 55 | 41 | 29m. | 0 | .05 | 0.0967 | .0130 | - | 5.35 | 2.93 | .0085 | .14 | 475 |
| February, . | 20,000 | 57 | 41 | 24m. | 0 | .05 | 0.0617 | .0137 | - | 5.20 | 2.72 | .0023 | .12 | 202 |
| March, . | 20,700 | 56 | 40 | 24m. | 0 | .04 | 0.0633 | .0112 | .0230 | 4.40 | 2.71 | .0002 | .13 | 46 |
| April, . . | 17,600 | 56 | 45 | 6m. | 0 | .06 | 0.0600 | .0117 | - | 6.60 | 3.02 | .0010 | .15 | 125 |
| May, . . | 20,700 | 58 | 52 | 16m. | 0 | .05 | 0.0243 | .0126 | - | 9.07 | 4.45 | .0007 | .20 | 70 |
| June, . . | 18,500 | 61 | 60 | 4m. | 0 | .04 | 0.0179 | .0154 | - | 13.10 | 7.14 | .0000 | .25 | 58 |
| July, . . | 18,500 | 70 | 65 | 5m. | 0 | .05 | 0.0047 | .0172 | - | 13.10 | 5.85 | .0000 | .15 | 34 |
| August, . | 19,300 | 73 | 71 | 3m. | 0 | .07 | 0.0063 | .0143 | - | 13.17 | 5.27 | .0000 | .18 | 50 |
| September, . | 16,000 | 68 | 68 | 1m. | 0 | .05 | 0.0043 | .0148 | - | 14.77 | 4.95 | .0000 | .18 | 130 |
| October, . | 19,300 | 61 | 60 | 3m. | 0 | .04 | 0.0052 | .0153 | - | 13.30 | 6.64 | .0000 | .13 | 31 |
| November, . | 18,500 | 61 | 54 | 5m. | 0 | .04 | 0.0053 | .0144 | - | 12.30 | 6.14 | .0000 | .13 | 34 |
| Average, . | 19,000 | 61 | 53 | 12m. | 0 | .05 | 0.0269 | .0136 | .0230 | 9.81 | 4.62 | .0016 | .16 | 120 |

## *Effluent of Filter No. 5C.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Length of Time Sewage remained on Surface. | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | | |
| December, . | 57,700 | 58 | 44 | 26m. | 0.7 | .22 | 0.5825 | .0418 | .0958 | 5.96 | 2.24 | .0026 | .48 | 9,800 |
| **1906.** | | | | | | | | | | | | | | |
| January, . | 60,000 | 56 | 43 | 53m. | 0.7 | .32 | 1.2000 | .0595 | .1056 | 5.85 | 2.03 | .0062 | .59 | 14,200 |
| February, . | 60,000 | 57 | 42 | 37m. | 0.3 | .23 | 0.9867 | .0460 | .0661 | 5.13 | 3.25 | .0087 | .36 | 4,900 |
| March, . | 60,000 | 57 | 42 | 25m. | 0.2 | .17 | 0.3084 | .0404 | .0784 | 6.53 | 3.44 | .0080 | .39 | 2,900 |
| April, . . | 57,600 | 56 | 48 | 3m. | 0.3 | .11 | 0.1205 | .0425 | .0674 | 8.53 | 4.76 | .0045 | .33 | 13,300 |
| May, . . | 52,600 | 58 | 55 | 3m. | 0.1— | .06 | 0.0614 | .0331 | - | 13.57 | 7.76 | .0007 | .44 | 1,167 |
| June, . . | 48,100 | 60 | 61 | 2m. | 0.1— | .09 | 0.0750 | .0310 | - | 11.70 | 6.47 | .0004 | .31 | 650 |
| July, . . | 46,200 | 69 | 69 | 2m. | 0.2 | .09 | 0.0826 | .0251 | - | 12.97 | 6.36 | .0001 | .25 | 39,000 |
| August, . | 50,000 | 73 | 75 | 2m. | 0.1— | .06 | 0.0231 | .0189 | - | 16.03 | 4.70 | .0001 | .33 | 3,450 |
| September, . | 44,000 | 69 | 71 | 1m. | 0.1— | .07 | 0.0114 | .0179 | - | 16.63 | 4.88 | .0001 | .19 | 1,000 |
| October, . | 50,000 | 60 | 63 | 5m. | 0.0 | .10 | 0.0570 | .0232 | - | 13.05 | 7.47 | .0002 | .24 | 800 |
| November, . | 48,100 | 61 | 58 | 9m. | 0.8 | .15 | 0.8385 | .0588 | - | 12.56 | 4.42 | .0027 | .67 | 3,200 |
| Average, . | 52,900 | 61 | 56 | 15m. | 0.2 | .15 | 0.3577 | .0361 | .0817 | 10.71 | 4.82 | .0024 | .38 | 7,900 |

## *Effluent of Filter No. 6.*

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Length of Time Sewage remained on Surface. | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | | |
| December, . | 60,000 | 57 | 44 | 1h. 33m. | 1.4 | .38 | 1.3788 | .0670 | .1488 | 6.59 | 2.19 | .0230 | .68 | 24,300 |
| **1906.** | | | | | | | | | | | | | | |
| January, . | 60,000 | 56 | 42 | 1h. 22m. | 0.6 | .32 | 1.3813 | .0665 | .1270 | 5.95 | 2.78 | .0300 | .58 | 13,400 |
| February, . | 60,000 | 56 | 42 | 1h. 36m. | 0.4 | .30 | 0.8950 | .0593 | - | 5.60 | 2.69 | .0307 | .46 | 8,600 |
| March, . . | 60,000 | 56 | 41 | 1h. 41m. | 1.3 | .41 | 1.0913 | .0945 | .1544 | 7.10 | 2.49 | .0145 | .79 | 16,500 |
| April, . . | 55,200 | 56 | 48 | 46m. | 0.6 | .31 | 1.2975 | .0910 | .1394 | 9.08 | 3.73 | .0465 | .61 | 22,790 |
| May, . . | 48,900 | 58 | 56 | 8m. | 0.2 | .20 | 0.3478 | .0623 | - | 14.93 | 6.31 | .0193 | .57 | 3,600 |
| June, . . | 46,200 | 61 | 60 | 5m. | 0.1— | .16 | 0.0814 | .0346 | - | 13.10 | 5.88 | .0002 | .40 | 200 |
| July, . . | 46,200 | 69 | 68 | 12m. | 0.3 | .20 | 0.2967 | .0473 | - | 17.07 | 4.67 | .0117 | .42 | 2,500 |
| August, . | 50,000 | 73 | 74 | 3m. | 0.1— | .18 | 0.0729 | .0332 | - | 17.60 | 5.71 | .0003 | .43 | 3,900 |
| September, . | 41,600 | 69 | 71 | 2m. | 0.6 | .18 | 0.0705 | .0347 | - | 14.97 | 6.31 | .0001 | .42 | 4,100 |
| October, . | 60,000 | 60 | 60 | 10m. | 0.1 | .12 | 0.2540 | .0395 | - | 15.60 | 5.96 | .0007 | .31 | 1,000 |
| November, . | 57,700 | 61 | 52 | 1h. 14m. | 2.0 | .26 | 1.1750 | .0960 | - | 13.20 | 2.27 | .0024 | .89 | 12,350 |
| Average, . | 53,800 | 61 | 55 | 44m. | 0.6 | .25 | 0.6947 | .0607 | .1424 | 11.73 | 4.25 | .0150 | .55 | 9,500 |

## *Effluent of Filter No. 9A.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Length of Time Sewage remained on Surface. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, | 57,700 | 58 | 47 | 1h. 31m. | 0.6 | .47 | 1.7800 | .0700 | .1248 | 6.60 | 2.28 | .0055 | .89 | 6,700 |
| **1906.** January, | 55,600 | 57 | 45 | 4h. 15m. | 0.1— | .32 | 0.9863 | .0565 | .1059 | 5.13 | 2.64 | .0075 | .56 | 1,140 |
| February, | 57,500 | 56 | 44 | 5h. 14m. | 0.1— | .28 | 0.6700 | .0553 | .0795 | 5.50 | 2.59 | .0167 | .46 | 455 |
| March, | 57,800 | 56 | 43 | 55m. | 0.2 | .32 | 1.1475 | .0580 | .0944 | 5.98 | 2.89 | .0045 | .65 | 1,900 |
| April, | 52,800 | 56 | 49 | 1h. 29m. | 0.1— | .24 | 0.6725 | .0565 | .0888 | 8.00 | 4.36 | .0095 | .48 | 1,538 |
| May, | 48,900 | 58 | 55 | 19m. | 0.1— | .20 | 0.1375 | .0428 | - | 15.60 | 5.74 | .0013 | .49 | 333 |
| June, | 48,100 | 61 | 61 | 13m. | 0.0 | .16 | 0.0121 | .0344 | - | 13.60 | 5.46 | .0000 | .38 | 400 |
| July, | 46,200 | 69 | 68 | 23m. | 0.2 | .20 | 0.3347 | .0460 | - | 17.67 | 4.48 | .0009 | .45 | 1,333 |
| August, | 50,000 | 73 | 74 | 11m. | 0.0 | .18 | 0.0108 | .0314 | - | 18.20 | 5.72 | .0000 | .42 | 517 |
| September, | 41,600 | 69 | 71 | 6m. | 0.1— | .16 | 0.0215 | .0311 | - | 17.70 | 4.65 | .0003 | .40 | 525 |
| October, | 60,000 | 60 | 62 | 12m. | 0.1— | .13 | 0.2500 | .0308 | - | 13.75 | 4.67 | .0001 | .36 | 1,900 |
| November, | 57,700 | 61 | 52 | 1h. 13m. | 1.5 | .34 | 0.8800 | .0760 | - | 12.75 | 1.77 | .0018 | .91 | 1,800 |
| Average, | 52,800 | 61 | 56 | 1h. 20m. | 0.2 | .25 | 0.5752 | .0491 | .0987 | 11.71 | 3.94 | .0040 | .54 | 1,500 |

## *Effluent of Filter No. 10.*

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Length of Time Sewage remained on Surface. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, | 25,000 | 58 | 48 | 41m. | 0.1 | .18 | 0.5165 | .0355 | .0843 | 6.04 | 2.54 | .0145 | .40 | 1,460 |
| **1906.** January, | 25,000 | 56 | 45 | 1h. 24m. | 0.3 | .21 | 0.7750 | .0440 | .0968 | 5.33 | 2.20 | .0115 | .42 | 2,140 |
| February, | 25,000 | 57 | 44 | 2h. 33m. | 0.1 | .21 | 0.3767 | .0407 | .0874 | 5.10 | 3.01 | .0060 | .41 | 1,400 |
| March, | 24,100 | 57 | 43 | 2h. 25m. | 0.6 | .24 | 0.6433 | .0450 | .0766 | 4.90 | 1.98 | .0100 | .53 | 2,600 |
| April, | 22,000 | 56 | 48 | 12m. | 0.3 | .26 | 1.4225 | .0705 | .1221 | 8.25 | 3.32 | .0320 | .59 | 4,063 |
| May, | 24,100 | 58 | 58 | 8m. | 0.2 | .22 | 0.3710 | .0485 | - | 15.50 | 4.49 | .0130 | .57 | 1,800 |
| June, | 24,000 | 60 | 57 | 9m. | 0.1— | .18 | 0.1462 | .0470 | - | 16.50 | 3.05 | .0011 | .45 | 975 |
| July, | 23,100 | 69 | 64 | 3m. | 0.2 | .19 | 0.1288 | .0415 | - | 18.00 | 3.31 | .0004 | .39 | 1,300 |
| August, | 25,000 | 73 | 71 | 4m. | 0.1— | .19 | 0.0802 | .0288 | - | 17.00 | 3.75 | .0008 | .44 | 350 |
| September, | 20,000 | 69 | 70 | 1m. | 0.1 | .16 | 0.0227 | .0263 | - | 17.17 | 4.18 | .0001 | .36 | 375 |
| October, | 25,000 | 60 | 63 | 3m. | 0.1 | .12 | 0.0202 | .0220 | - | 13.25 | 4.80 | .0007 | .26 | 585 |
| November, | 24,000 | 60 | 54 | 4m. | 0.0 | .11 | 0.1703 | .0290 | - | 12.10 | 3.44 | .0018 | .37 | 150 |
| Average, | 23,900 | 61 | 55 | 39m. | 0.2 | .19 | 0.3894 | .0399 | .0934 | 11.60 | 3.34 | .0078 | .43 | 1,430 |

*Effluent of Filter No. 305.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | |
| **1906.** | | | | | | | | | | | | |
| August,[1] . . | 60,000 | 73 | 74 | 0.1— | 0.8 | 0.1896 | .0132 | 14.30 | 0.21 | .0200 | .18 | 4,000 |
| September, . | 57,600 | 69 | 71 | 0.1— | 0.4 | 0.7223 | .0606 | 15.80 | 4.24 | .0485 | .13 | 1,200 |
| October, . . | 60,000 | 60 | 62 | 0.0 | 0.3 | 0.0870 | .0172 | 12.65 | 5.73 | .0010 | .11 | 550 |
| November, . | 57,600 | 60 | 52 | 0.2 | 0.6 | 1.6700 | .0460 | 12.75 | 3.99 | .0044 | .31 | 2,225 |
| Average, . | 58,800 | 66 | 65 | 0.0 | 0.5 | 0.6422 | .0368 | 13.88 | 3.54 | .0185 | .18 | 2,000 |

*Effluent of Filter No. 306.*

| Date. | Quantity Applied. | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total Albuminoid. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | | | | |
| August,[1] . . | 60,000 | 73 | 74 | 0.1— | 0.3 | 0.0608 | .0084 | 8.50 | 0.17 | .0140 | .10 | 4,600 |
| September, . | 55,200 | 69 | 72 | 0.1— | 0.6 | 0.1807 | .0196 | 10.00 | 2.77 | .0664 | .10 | 2,900 |
| October, . . | 60,000 | 60 | 62 | 0.0 | 0.3 | 0.0564 | .0120 | 8.20 | 4.33 | .0042 | .08 | 270 |
| November, . | 57,600 | 61 | 52 | 0.0 | 0.3 | 0.7950 | .0300 | 7.50 | 2.31 | .0025 | .32 | 1,825 |
| Average, . | 58,200 | 66 | 65 | 0.1— | 0.4 | 0.2732 | .0175 | 8.55 | 2.40 | .0218 | .15 | 2,300 |

[1] Filter started Aug. 24, 1906.

## Operation of Septic Tanks.

During the year, two septic tanks were continued in operation at the station, namely, Tanks A and F. Tank A was first put into operation during 1897, the results obtained by it have been presented in each report, and a summary of these results to date is given on page 233 of this report. Septic Tank F, put into operation during 1904, has always received the heavy sludge resulting from sedimentation of sewage, and the results of this tank to date are presented on page 234. Septic Tanks G and H were discontinued at the end of 1905, and the results obtained by them are presented on pages 234 and 235.

Following tables present the average analyses of the sewage entering and the effluents from Tanks A and F during the year. These averages are of samples collected each week during the year.

*Sewage applied to Septic Tank A.*

[Parts per 100,000.]

| | Temperature (Deg. F.). | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|
| | | Free. | Albuminoid. Total. | Albuminoid. In Solution. | Total. | In Solution. | | | |
| Average, | 64 | 4.30 | .77 | .33 | 1.22 | .51 | 13.96 | 4.67 | 860,800 |

*Effluent of Septic Tank A.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Average, | 65 | 4.33 | - | - | 0.69 | .40 | 13.45 | 2.83 | 445,200 |

*Sewage applied to Septic Tank F.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Average, | 61 | 5.33 | - | - | 2.06 | .76 | 11.20 | 5.58 | 1,375,000 |

*Effluent of Septic Tank F.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Average, | 65 | 6.29 | - | - | 0.62 | .29 | 12.13 | 2.44 | 284,200 |

*Solids in Sewage applied to Septic Tank A.*

[Parts per 100,000.]

| Date. | Unfiltered. Total. | Unfiltered. Loss on Ignition. | Unfiltered. Fixed. | Filtered. Total. | Filtered. Loss on Ignition. | Filtered. Fixed. | In Suspension. Total. | In Suspension. Loss on Ignition. | In Suspension. Fixed. |
|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, | 53.1 | 29.4 | 23.6 | 35.3 | 14.8 | 20.5 | 17.8 | 14.7 | 3.1 |
| **1906.** January, | 45.1 | 24.3 | 20.8 | 33.9 | 14.3 | 19.6 | 11.2 | 10.0 | 1.2 |
| February, | 48.3 | 30.2 | 18.1 | 25.5 | 12.1 | 13.4 | 22.8 | 18.1 | 4.7 |
| March, | 60.3 | 29.8 | 30.5 | 39.8 | 13.9 | 25.9 | 20.5 | 15.9 | 4.6 |
| April, | 58.7 | 29.7 | 29.0 | 36.2 | 12.7 | 23.5 | 22.5 | 17.0 | 5.5 |
| May, | 95.7 | 41.7 | 54.0 | 64.1 | 18.5 | 45.6 | 31.6 | 23.2 | 8.4 |
| June, | 87.8 | 45.0 | 42.8 | 56.1 | 20.6 | 35.5 | 31.7 | 24.4 | 7.3 |
| July, | 96.5 | 35.3 | 61.2 | 69.4 | 15.0 | 54.4 | 27.1 | 20.3 | 6.8 |
| August, | 81.8 | 30.7 | 51.1 | 65.6 | 20.5 | 45.1 | 16.2 | 10.2 | 6.0 |
| September, | 65.9 | 24.1 | 41.8 | 48.2 | 11.6 | 36.6 | 17.7 | 12.5 | 5.2 |
| October, | 72.0 | 32.6 | 39.4 | 56.2 | 20.6 | 35.6 | 15.8 | 12.0 | 3.8 |
| November, | 79.7 | 36.5 | 43.2 | 57.7 | 19.5 | 38.2 | 22.0 | 17.0 | 5.0 |
| Average, | 70.4 | 32.4 | 38.0 | 49.0 | 16.2 | 32.8 | 21.4 | 16.3 | 5.1 |

*Solids in Effluent of Septic Tank A.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Average, | 52.2 | 18.3 | 33.9 | 46.3 | 13.9 | 32.4 | 5.8 | 4.4 | 1.4 |

*Solids in Sewage applied to Septic Tank F.*

[Parts per 100,000.]

| Date. | Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| Average, | 73.3 | 40.5 | 36.8 | 48.0 | 17.7 | 30.3 | 29.3 | 22.8 | 6.5 |

*Solids in Effluent of Septic Tank F.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Average, | 49.2 | 14.8 | 34.4 | 41.0 | 9.9 | 31.1 | 8.1 | 4.8 | 3.3 |

## Sand Filtration of Septic Sewage.

### *Filter No. 100.*

Filter No. 100 is 1/20000 of an acre in area, and contained, during 1906, 42 inches in depth of sand of an effective size of 0.26 millimeter. It was first put into operation on Jan. 1, 1898, and has always been flooded with the effluent of Septic Tank A. During the year, it was operated at a rate of approximately 200,000 gallons per acre daily, — from Dec. 1, 1905, to Sept. 26, 1906, — the sewage being applied in one dose; and from September 27 to November 30, in two equal doses eight hours apart. The surface of the filter was raked to a depth of 3 inches about once a week throughout the year, and on December 3 it was dug over to a depth of 6 inches. The filter was also allowed to rest from October 10 to 18, inclusive.

*Effluent of Filter No. 100.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, | 184,600 | 56 | 61 | 1.0 | .30 | 0.5100 | .0670 | .1588 | 7.88 | 3.15 | .0023 | 0.62 | 45,000 |
| **1906.** | | | | | | | | | | | | | |
| January, | 200,000 | 56 | 61 | 0.8 | .24 | 0.6700 | .0580 | .1088 | 10.22 | 3.24 | .0008 | 0.60 | 17,000 |
| February, | 200,000 | 54 | 61 | 0.5 | .22 | 0.3500 | .0560 | - | 4.10 | 2.69 | .0002 | 0.44 | 7,750 |
| March, | 200,000 | 60 | 61 | 0.9 | .38 | 1.1325 | .0890 | .1722 | 8.55 | 3.15 | .0004 | 0.99 | 15,900 |
| April, | 200,000 | 62 | 62 | 0.5 | .26 | 0.8200 | .0640 | .1046 | 10.05 | 3.36 | .0040 | 0.54 | 18,500 |
| May, | 200,000 | 65 | 61 | 1.5 | .38 | 0.8400 | .0970 | - | 20.15 | 3.87 | .0012 | 0.78 | 21,200 |
| June, | 200,000 | 70 | 66 | 1.0 | .21 | 0.2930 | .0800 | - | 14.55 | 3.71 | .0004 | 0.59 | 14,500 |
| July, | 200,000 | 78 | 72 | 1.1 | .21 | 0.4100 | .0560 | - | 18.30 | 3.99 | .0010 | 0.50 | 5,258 |
| August, | 200,000 | 79 | 71 | 2.0 | .23 | 0.1950 | .0545 | - | 14.60 | 3.74 | .0010 | 0.63 | 40,500 |
| September, | 200,000 | 74 | 66 | 3.0 | .40 | 0.6500 | .0770 | - | 15.85 | 3.32 | .0040 | 0.75 | 21,500 |
| October, | 151,900 | 65 | 62 | 1.3 | .73 | 2.0825 | .2570 | - | 15.48 | 3.19 | .0115 | 3.39 | 13,500 |
| November, | 200,000 | 58 | 54 | 2.0 | .90 | 1.3600 | .1540 | - | 13.10 | 1.17 | .0064 | 1.67 | 31,200 |
| Average, | 194,700 | 65 | 63 | 1.3 | .37 | 0.7719 | .0920 | .1336 | 12.74 | 3.22 | .0028 | 0.96 | 21,000 |

## *Filter No. 242.*

Filter No. 242 is constructed of 48 inches in depth of sand of an effective size of 0.41 millimeter, and was first put into operation Feb. 1, 1904. The effluent of Septic Tank F has been applied to this filter at a rate of about 100,000 gallons per acre daily. The surface of the filter was raked to a depth of 3 inches weekly throughout the year.

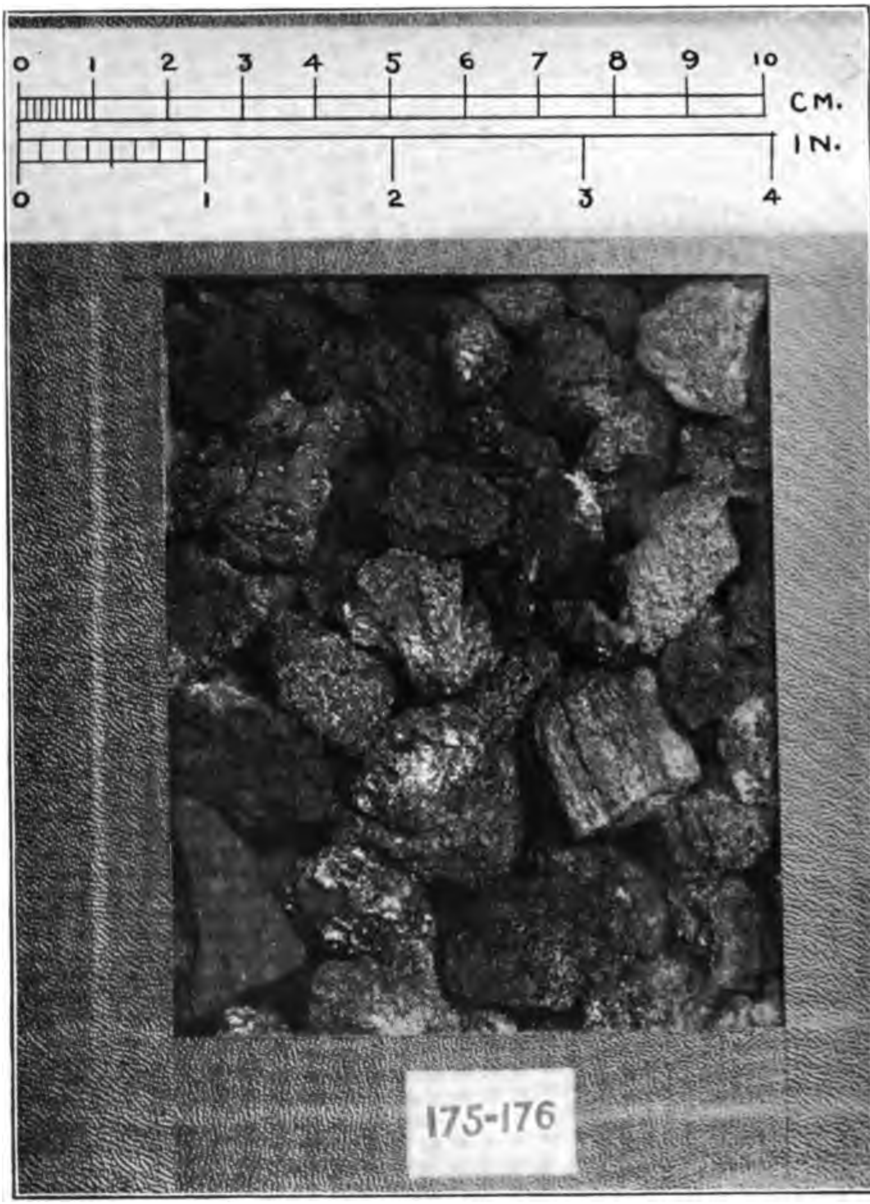
*Effluent of Filter No. 242.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** | | | | | | | | | | | | |
| December, | 100,000 | 62 | 65 | 0 | .12 | .1200 | .0180 | 6.90 | 4.41 | .0001 | 1.42 | 48 |
| **1906.** | | | | | | | | | | | | |
| January, | 100,000 | 58 | 66 | 0 | .06 | .0750 | .0260 | - | 4.22 | .0002 | 0.15 | 95 |
| February, | 100,000 | 62 | 66 | 0 | .10 | .1480 | .0260 | 5.40 | 3.37 | .0002 | 0.14 | 75 |
| March, | 100,000 | 65 | 68 | 0 | .06 | .2570 | .0240 | 6.30 | 4.29 | .0000 | 0.18 | 425 |
| April, | 100,000 | 63 | 70 | 0 | .15 | .1825 | .0270 | 9.40 | 4.24 | .0002 | 0.14 | 75 |
| May, | 100,000 | 62 | 67 | 0 | .10 | .4900 | .0390 | 19.30 | 5.80 | .0004 | 0.22 | 82 |
| June, | 95,300 | 65 | 69 | 0 | .09 | .2900 | .0380 | 17.00 | 5.07 | .0003 | 0.27 | 53 |
| July, | 95,600 | 76 | 74 | 0 | .08 | .2150 | .0410 | 18.95 | 5.25 | .0005 | 0.14 | 430 |
| August, | 100,000 | 77 | 75 | 0 | .04 | .0980 | .0170 | 14.05 | 4.94 | .0001 | 0.28 | 945 |
| September, | 95,000 | 71 | - | 0 | .08 | .0630 | .0300 | 13.55 | 4.86 | .0003 | 0.20 | 111 |
| October, | 100,000 | 65 | 67 | 0 | .06 | .4270 | .0380 | 13.60 | 6.01 | .0003 | 0.27 | 40 |
| November, | 100,000 | 69 | - | 0 | .12 | .4300 | .0400 | 13.60 | 5.46 | .0000 | 0.33 | 28 |
| Average, | 98,800 | 66 | 69 | 0 | .09 | .2330 | .0303 | 12.55 | 4.88 | .0002 | 0.31 | 200 |

## Operation of Contact Filters.

During the year, six contact filters were in operation at the station, namely, Filters Nos. 175, 176, 221, 237, 251 and 252. Of these, Filter No. 251 became so badly clogged that it was discontinued, and the filtering material of Filter No. 221 is becoming heavily coated with accumulated matter. Filters Nos. 175 and 176, on the other hand, lost little, if any, open space during the year. A discussion in regard to the results of these filters in the actual disposal of organic matter is given on pages 217–222, inclusive. Determinations of the oxygen in the effluents of these filters were made throughout the year, and the average per cent. of saturation was as follows: Filter No. 175, 14.2 per cent.; Filter No.




COKE.—FILTERS NOS. 175 AND 176.

176, 6.9 per cent.; Filter No. 221, 6.7 per cent.; Filter No. 251, 5.0 per cent.; and Filter No. 252, 4.2 per cent. Throughout the year, also, analyses of the sewage actually applied to each of these filters were made, and the average analysis for the year is given with the analyses of the effluent. The results of incubation tests have been given on page 228.

*Filters Nos. 175 and 176.*

Filters Nos. 175 and 176, first put into operation June 3, 1901, were continued in use during 1906. Each filter is 5 feet in depth, and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a ½-inch mesh and practically none through a sieve with a ¼-inch mesh. Filter No. 175 has always received sewage that has passed through a coke or coal strainer, and Filter No. 176 has received untreated station sewage. Each of these filters is allowed to rest one week in each six. During the year, Filter No. 175 was operated at an average rate of 497,000 gallons, and Filter No. 176 at an average rate of 491,000 gallons per acre daily. No appreciable loss of open space was noted in either filter during the year.

*Filter No. 221.*

Filter No. 221 is $\frac{1}{5000}$ of an acre in area, and is constructed of 42 inches in depth of broken stone of such a size that all pieces will pass through a sieve with a 1-inch mesh, 25 per cent. through a ½-inch mesh, but none through a sieve with a ¼-inch mesh. The underdrains of this filter are constructed of 6 inches in depth of cobble stones laid upon brick channels. This filter was put into operation July 7, 1903, and during 1906 was operated at an average rate of 469,000 gallons per acre daily. From Dec. 1, 1905, until Aug. 10, 1906, the filter was flooded with station sewage, after which time settled sewage was applied. A decrease of about 25 per cent. occurred in the open space of this filter between January 31 and August 15, which will account for the diminution in rate during the last three months of the year, as during the previous year nitrification was very feeble in this filter, although the amount of nitrates present in the effluent increased somewhat after the application of settled sewage was begun.

## Double Contact Filtration.

*Filter No. 237.*

Filter No. 237 is $\frac{1}{20000}$ of an acre in area, and is constructed of clinker varying in size from ¾ to 1¾ inches in diameter, the clinker being laid over brick underdrains, and the depth of the filter, including

the underdrains, being 5 feet 6 inches. The filter was first put into operation Jan. 1, 1904, and has received the effluent of Filter No. 221 since that time, being flooded twice daily. The average rate of filtration during the year was 1,622,000 gallons per acre daily. Between Dec. 1, 1905, and Aug. 16, 1906, a reduction of about 15 per cent. in the open space of the filter occurred.

*Filter No. 251.*

Filter No. 251, $\frac{1}{10000}$ of an acre in area, and constructed of 28 inches of Pennsylvania coke of such size that all the pieces will pass through a sieve with a $\frac{1}{2}$-inch mesh and practically none through a sieve with a $\frac{1}{8}$-inch mesh, was first put into operation Aug. 1, 1904, and has been flooded since that time with the effluent of Septic Tank A. The average rate of filtration during the year was 775,000 gallons per acre daily.

*Filter No. 252.*

Filter No. 252, $\frac{1}{10000}$ of an acre in area, is constructed of 36 inches in depth of coke breeze over 6 inches in depth of brick underdrains. It received the effluents from Filters Nos. 233 and 235 after passage through a settling basin, at an average rate of 999,000 gallons per acre daily. During March, the filtering material became so badly clogged that it was very difficult to operate the filter at the prescribed rate, and this condition was not improved by stirring up the material to a depth of 6 inches. The filter was discontinued on March 31, 1906.

*Average Analyses of Sewage applied to Contact Filters.*

*Average Sewage applied to Filter No. 175.*

[Parts per 100,000.]

| 1906. | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | Free. | Albuminoid. Total. | Albuminoid. In Solution. | Total. | In Solution. | | |
| February — November, inclusive, . | 4.06 | .55 | .40 | .98 | .69 | 15.78 | 3.29 |

*Average Sewage applied to Filter No. 176.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| February — November, inclusive, . | 4.89 | .58 | .42 | .98 | .69 | 15.44 | 3.60 |

*Average Sewage applied to Filter No. 221.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| February — November, inclusive, . | 3.72 | .59 | .39 | .99 | .61 | 14.76 | 3.95 |

## *Average Analyses of Sewage applied to Contact Filters* — Concluded.

*Average Sewage applied to Filter No. 237.*

[Parts per 100,000.]

| 1906. | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | Free. | Albuminoid. Total. | Albuminoid. In Solution. | Total. | In Solution. | | |
| February — November, inclusive, . . | 2.60 | .27 | .19 | .48 | .36 | 14.72 | 2.12 |

*Average Sewage applied to Filter No. 251.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| February — November, inclusive, . . | 4.11 | .43 | .31 | .72 | .57 | 13.10 | 2.66 |

## *Effluent of Filter No. 175.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). Sewage. | Temperature (Deg. F.). Effluent. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** | | | | | | | | | | | | | | |
| December, . | 489,800 | 38 | 57 | 8.3 | .68 | 2.0000 | .2040 | .1450 | .3850 | 5.58 | 2.24 | .0740 | 1.62 | 1,048,000 |
| **1906.** | | | | | | | | | | | | | | |
| January, . | 560,000 | 39 | - | 7.0 | .63 | 1.2400 | .1840 | .1380 | .3498 | 5.15 | 2.05 | .0340 | 1.70 | 400,000 |
| February, . | 525,000 | 38 | - | 10.5 | .65 | 1.1800 | .2120 | .1490 | .4240 | 4.98 | 2.35 | .0750 | 2.37 | 495,000 |
| March, . . | 480,000 | 39 | - | 7.0 | .70 | 1.6750 | .2700 | .2300 | .4830 | 6.80 | 2.00 | .1010 | 2.10 | 277,000 |
| April, . . | 477,600 | 44 | - | 6.5 | .72 | 1.5000 | .2580 | .2360 | .4642 | 9.35 | 2.70 | .0760 | 1.62 | 153,300 |
| May, . . | 533,000 | 56 | - | - | .60 | 1.6800 | .3200 | .1920 | .4510 | 21.00 | 1.78 | .0680 | 1.07 | 202,500 |
| June, . . | 438,500 | 61 | - | - | .65 | 1.0600 | .2020 | .1420 | .4296 | 19.50 | 2.39 | .0400 | 1.95 | 207,500 |
| July, . . | 465,000 | 70 | - | 3.0 | .52 | 0.5600 | .1760 | .1360 | .3248 | 20.20 | 2.73 | .0360 | 1.60 | 890,000 |
| August, . | 520,000 | 73 | - | 3.0 | .60 | 0.4800 | .1760 | .1480 | .3576 | 22.00 | 2.76 | .0140 | 2.18 | 862,500 |
| September, . | 552,000 | 69 | - | 6.0 | .70 | 0.7600 | .2760 | .1800 | .4248 | 16.70 | 2.85 | .0220 | 2.01 | 351,000 |
| October, . | 467,000 | 67 | - | 6.0 | .70 | 1.1200 | .3320 | .2480 | .5314 | 17.50 | 1.83 | .0160 | 2.40 | 368,300 |
| November, . | 459,600 | 50 | - | 3.0 | .55 | 1.4800 | .3720 | .2640 | .7020 | 15.20 | 1.96 | .0120 | 2.47 | 238,300 |
| Average, . | 497,300 | 54 | - | 6.0 | .64 | 1.2280 | .2485 | .1840 | .4439 | 13.66 | 2.30 | .0473 | 1.92 | 457,800 |

### *Average Solids in Effluent of Filter No. 175.*

[Parts per 100,000.]

| Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|
| Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 55.3 | 15.6 | 39.7 | 50.5 | 13.7 | 36.8 | 4.8 | 1.9 | 2.9 |

### *Effluent of Filter No. 176.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Albuminoid. | | | | | | | |
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total. | In Solution. | | | Nitrates. | Nitrites. | | |
| **1905.** December, | 495,000 | 38 | 56 | 7.0 | 0.75 | 2.4200 | .1990 | .1630 | .4172 | 5.50 | 1.01 | .0250 | 1.70 | 688,000 |
| **1906.** January, | 560,000 | 39 | - | 7.0 | 0.70 | 1.6800 | .1800 | .1540 | .3637 | 5.33 | 0.89 | .0160 | 1.66 | 253,300 |
| February, | 525,000 | 38 | - | 8.0 | 0.65 | 1.2800 | .1610 | .1420 | .3526 | 5.00 | 0.83 | .0650 | 1.46 | 282,500 |
| March, | 467,000 | 39 | - | 5.8 | 0.75 | 1.8400 | .2360 | .2060 | .4559 | 6.85 | 1.00 | .0550 | 1.84 | 232,000 |
| April, | 455,800 | 44 | - | 7.5 | 0.72 | 2.4600 | .2820 | .2200 | .5643 | 9.10 | 0.90 | .0160 | 2.11 | 85,000 |
| May, | 595,000 | 56 | - | - | 1.00 | 2.5200 | .3080 | .2880 | .5724 | 21.20 | 0.11 | .0040 | 1.40 | 410,000 |
| June, | 434,600 | 61 | - | - | 1.40 | 1.4800 | .2540 | .1320 | .5346 | 18.80 | 0.57 | .0020 | 2.10 | 323,000 |
| July, | 453,000 | 70 | - | 5.0 | 1.00 | 1.3600 | .2160 | .0920 | .4444 | 19.90 | 0.56 | .0040 | 1.80 | 387,500 |
| August, | 494,000 | 73 | - | 3.0 | 1.50 | 1.0000 | .1640 | .1000 | .3788 | 22.00 | 0.32 | .0010 | 1.88 | 507,500 |
| September, | 515,000 | 69 | - | 7.0 | 1.00 | 1.6800 | .2600 | .2320 | .4214 | 18.10 | 0.55 | .0020 | 1.88 | 180,000 |
| October, | 449,000 | 67 | - | 8.0 | 1.50 | 1.6000 | .2840 | .2480 | .5362 | 17.50 | 0.55 | .0060 | 2.67 | 145,000 |
| November, | 444,200 | 50 | - | 6.0 | 1.50 | 2.0000 | .3560 | .3080 | .5690 | 16.30 | 0.40 | .0010 | 2.35 | 202,500 |
| Average, | 490,600 | 54 | - | 6.4 | 1.04 | 1.7767 | .2417 | .1904 | .4675 | 13.80 | 0.65 | .0164 | 1.90 | 308,000 |

### *Average Solids in Effluent of Filter No. 176.*

[Parts per 100,000.]

| Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|
| Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 47.5 | 12.5 | 35.0 | 45.2 | .11.1 | 34.1 | - | - | - |

APPEARANCE OF MATERIAL IN FILTERS NOS. 175 AND 176 AFTER A PERIOD OF USE.

## *Effluent of Filter No. 221.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Albuminoid. | | | | | | | |
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total. | In Solution. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | | |
| December, | 590,000 | 38 | 52 | 8.0 | 0.80 | 1.6400 | .2355 | .1700 | .5648 | 7.20 | .07 | .0004 | 1.94 | 1,010,000 |
| **1906.** | | | | | | | | | | | | | | |
| January, | 587,000 | 39 | - | 9.5 | 0.80 | 1.6300 | .2480 | .1940 | .4853 | 7.55 | .11 | .0005 | 2.06 | 215,000 |
| February, | 490,000 | 38 | - | 9.5 | 0.97 | 1.6800 | .2260 | .1760 | .4223 | 5.90 | .06 | .0360 | 1.50 | 275,000 |
| March, | 500,000 | 39 | - | 9.5 | 1.25 | 2.1100 | .2885 | .2080 | .5560 | 9.00 | .08 | .0020 | 2.45 | 400,000 |
| April, | 490,000 | 44 | - | 11.5 | 1.30 | 2.5500 | .3675 | .2060 | .6822 | 10.45 | .05 | .0050 | 2.37 | 340,000 |
| May, | 491,000 | 56 | - | - | 1.40 | 4.0625 | .4150 | .2900 | .6200 | 16.30 | .10 | .0020 | 2.05 | 225,000 |
| June, | 480,800 | 61 | - | - | 1.00 | 4.5625 | .3350 | .2280 | .6298 | 18.90 | .05 | .0010 | 3.10 | 185,000 |
| July, | 500,000 | 70 | - | 7.0 | 1.50 | 4.1875 | .3450 | .2450 | .5348 | 18.60 | .09 | .0030 | 2.55 | 365,000 |
| August, | 422,000 | 73 | - | 7.0 | 1.00 | 2.6500 | .2850 | .1800 | .4328 | 18.60 | .05 | .0060 | 2.79 | 310,000 |
| September, | 360,000 | 67 | - | 10.0 | 1.20 | 2.9000 | .2950 | .1880 | .5646 | 16.90 | .13 | .0320 | 2.40 | 372,500 |
| October, | 360,000 | 59 | - | 6.5 | 1.20 | 1.6500 | .2760 | .2320 | .4460 | 14.40 | .22 | .0300 | 2.41 | 392,500 |
| November, | 360,000 | 54 | - | 5.0 | 0.65 | 2.0000 | .2800 | .2280 | .6494 | 13.90 | .11 | .0050 | 2.52 | 283,300 |
| Average, | 469,200 | 53 | - | 8.3 | 1.09 | 2.6352 | .2997 | .2121 | .5490 | 13.14 | .09 | .0102 | 2.35 | 364,400 |

## *Average Solids in Effluent of Filter No. 221.*

[Parts per 100,000.]

| Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|
| Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 49.8 | 14.7 | 35.1 | 46.6 | 12.5 | 34.1 | 3.1 | 2.1 | 1.0 |

## *Effluent of Filter No. 237.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Albuminoid. | | | | | | | |
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total. | In Solution. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | | |
| December, . | 1,680,000 | 52 | 53 | 7.0 | .60 | 0.4100 | .1780 | .1000 | .3501 | 7.38 | 1.14 | .0015 | 1.34 | 490,000 |
| **1906.** | | | | | | | | | | | | | | |
| January, . | 1,720,000 | – | – | 11.0 | .68 | 0.5075 | .3175 | .1410 | .6552 | 7.45 | 1.03 | .0060 | 2.13 | 435,000 |
| February, . | 1,684,000 | – | – | 10.5 | .58 | 0.4013 | .2025 | .1120 | .3886 | 6.20 | 0.83 | .0470 | 1.47 | 70,000 |
| March, . . | 1,720,000 | – | – | 8.0 | .53 | 0.6000 | .1700 | .1340 | .3424 | 9.10 | 0.88 | .0070 | 1.65 | 160,000 |
| April, . . | 1,725,600 | – | – | 10.0 | .72 | 0.9600 | .2860 | .1410 | .6613 | 10.55 | 1.29 | .0120 | 1.99 | 585,000 |
| May, . . | 1,656,000 | – | – | – | .50 | 1.9200 | .3200 | .1820 | .5690 | 17.10 | 2.43 | .0040 | 1.60 | 340,000 |
| June, . . | 1,654,000 | – | – | – | .75 | 2.3500 | .2920 | .1314 | .5830 | 18.90 | 1.74 | .0220 | 2.27 | 190,000 |
| July, . . | 1,720,000 | – | – | – | .65 | 1.8000 | .2720 | .1720 | .4576 | 19.50 | 2.04 | .0640 | 2.03 | 165,000 |
| August, . | 1,580,000 | – | – | – | .75 | 1.0800 | .1880 | .1520 | .3558 | 18.80 | 2.36 | .0360 | 1.92 | 305,000 |
| September, . | 1,440,000 | – | – | 4.0 | .65 | 1.1600 | .2480 | .2080 | .4248 | 17.00 | 1.74 | .0240 | 2.05 | 286,700 |
| October, . | 1,440,000 | – | – | 3.0 | .70 | 1.1200 | .2040 | .1800 | .4412 | 14.50 | 1.16 | .0130 | 1.67 | 257,500 |
| November, . | 1,440,000 | – | – | 3.0 | .60 | 0.6000 | .2240 | .2000 | .5002 | 13.90 | 1.26 | .0010 | 1.36 | 586,700 |
| Average, . | 1,621,600 | – | – | 7.1 | .64 | 1.0757 | .2418 | .1547 | .4733 | 12.53 | 1.49 | .0198 | 1.79 | 318,400 |

## *Average Solids in Effluent of Filter No. 237.*

[Parts per 100,000.]

| Unfiltered. | | | Filtered. | | | In Suspension. | | |
|---|---|---|---|---|---|---|---|---|
| Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. | Total. | Loss on Ignition. | Fixed. |
| 52.5 | 15.5 | 37.0 | 45.2 | 10.9 | 34.3 | 7.3 | 4.6 | 2.7 |

## *Effluent of Filter No. 251.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.) Sewage. | Appearance. | | Ammonia. | Albuminoid. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turbidity. | Color. | Free. | Total. | In Solution. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, | 800,000 | 56 | 10.0 | .71 | 2.3375 | .2090 | .1460 | .4709 | 9.25 | 0.49 | .0015 | 2.13 | 790,000 |
| **1906.** | | | | | | | | | | | | | |
| January, | 800,000 | 56 | 13.0 | .80 | 2.3600 | .3060 | .1970 | .5363 | 8.25 | 0.68 | .0055 | 2.51 | 350,000 |
| February, | 783,000 | 54 | 8.3 | .82 | 1.7750 | .2745 | .2030 | .5379 | 5.90 | 0.39 | .1775 | 1.96 | 270,000 |
| March, | 800,000 | 60 | 11.0 | .90 | 2.2200 | .2960 | .2570 | .5806 | 9.35 | 0.24 | .0030 | 2.22 | 218,000 |
| April, | 784,000 | 62 | 10.5 | .67 | 2.3000 | .3140 | .2400 | .6150 | 10.20 | 0.89 | .0040 | 2.35 | 700,000 |
| May, | 756,000 | 65 | - | .90 | 3.3500 | .3400 | .2700 | .5708 | 16.20 | 0.80 | .0040 | 2.95 | 280,000 |
| June, | 769,200 | 70 | - | .60 | 2.6000 | .3120 | .2160 | .5216 | 15.25 | 0.90 | .0060 | 2.29 | 610,000 |
| July, | 800,000 | 78 | - | .60 | 1.6000 | .2640 | .1880 | .4396 | 17.50 | 1.12 | .0150 | 2.18 | 145,000 |
| August, | 778,000 | 79 | - | .65 | 1.2800 | .2160 | .1560 | .4576 | 16.00 | 1.31 | .0140 | 2.02 | 305,000 |
| September, | 714,000 | 74 | 6.0 | .70 | 2.6800 | .3280 | .2520 | .6232 | 13.70 | 1.21 | .0040 | 2.84 | 605,000 |
| October, | 760,000 | 65 | 6.0 | .70 | 2.1500 | .3550 | .2400 | .7724 | 13.70 | 1.20 | .0030 | 2.40 | 290,000 |
| November, | 760,000 | 58 | 5.0 | .50 | 2.4000 | .3750 | .2400 | .5970 | 13.20 | 0.44 | .0030 | 2.32 | 423,300 |
| Average, | 775,400 | 65 | 8.7 | .71 | 2.2544 | .2991 | .2171 | .5602 | 12.38 | 0.81 | .0200 | 2.35 | 415,500 |

## *Effluent of Filter No. 252.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, | 1,050,000 | 57 | 55 | 0.0 | .12 | 0.0256 | .0183 | - | 6.13 | 2.25 | .0010 | .45 | 950 |
| **1906.** | | | | | | | | | | | | | |
| January, | 1,020,000 | 55 | 53 | 0.2 | .29 | 0.1764 | .0376 | .0709 | 6.75 | 2.05 | .0052 | .41 | 3,300 |
| February, | 1,020,000 | 54 | 52 | 0.1 | .30 | 0.3700 | .0500 | .0935 | 3.50 | 1.42 | .0120 | .40 | 4,250 |
| March, | 896,300 | 57 | 54 | 0.1 | .34 | 1.0025 | .0470 | .0717 | 7.30 | 2.06 | .0011 | .44 | 2,200 |
| April,[1] | 1,008,000 | - | - | - | - | - | - | - | - | - | - | - | - |
| Average, | 999,000 | 56 | 54 | 0.1 | .26 | 0.3936 | .0382 | .0787 | 5.92 | 1.95 | .0048 | .43 | 2,675 |

[1] Discontinued April 7.

## Sprinkling or Trickling Filters.

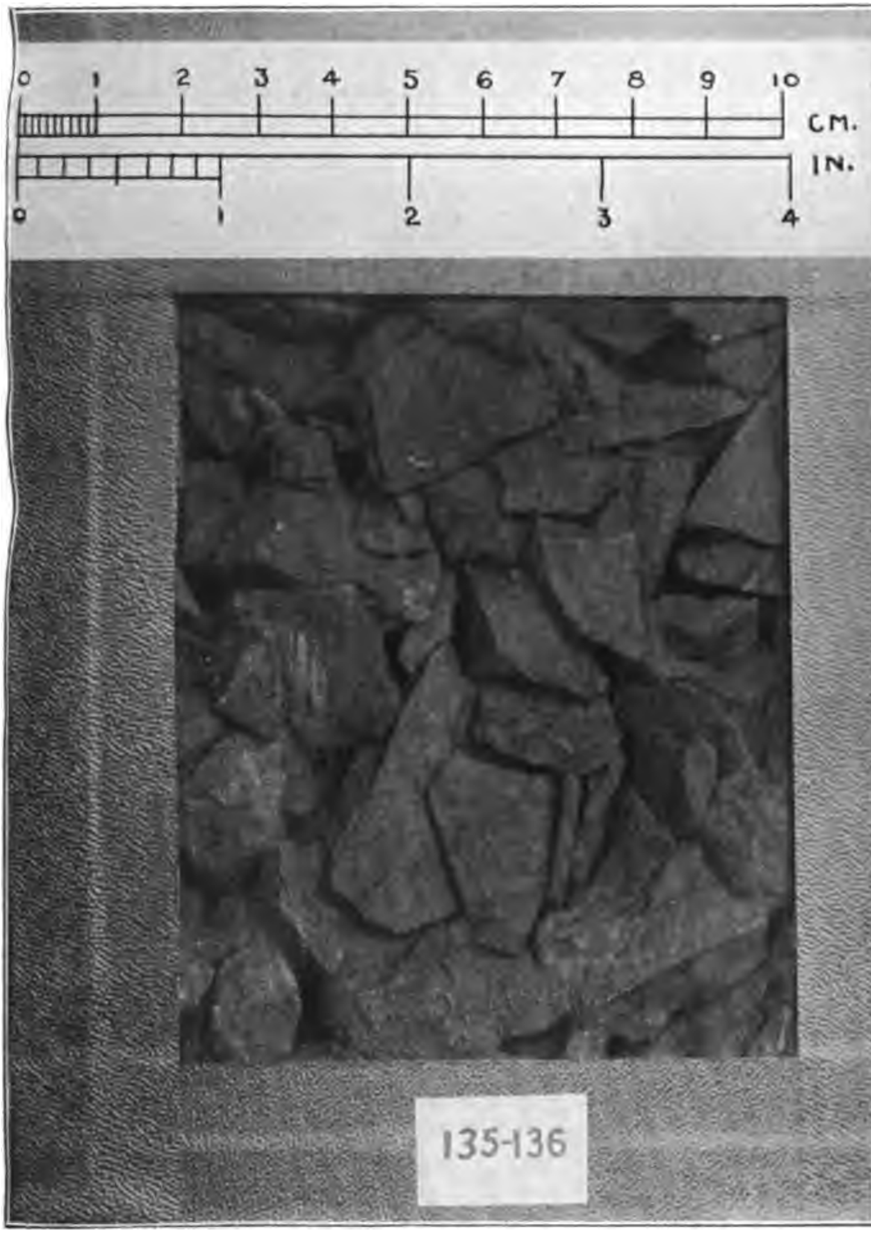
During the year seven sprinkling filters were in operation. Six of these filters are at the experiment station, and each is $\frac{1}{20000}$ of an acre in area; one filter, No. 222, $\frac{1}{200}$ of an acre in area, is located at the Andover filtration area.

Interesting experiments were made with Filters Nos. 135 and 136, each of which is only 20 inches in diameter and 11 feet 10 inches deep, in regard to methods of distribution, etc., required in order to supply sufficient air to the filters. These experiments are described on page 244.

A new method for the distribution of sewage on sprinkling filters is described in connection with Filter No. 222.

### *Filters Nos. 135 and 136.*

Filters Nos. 135 and 136 were first put into operation on Nov. 28, 1899. Each of these filters is 11 feet 10 inches in depth, and constructed of broken stone, all of which will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a ½-inch mesh, and 4 per cent. through a screen with a ¼-inch mesh. Sewage is distributed over the surface of these filters, as over all similar filters at the station, by means of automatic tipping basins. From May 1 to May 30, the perforated pan under these tipping basins was removed, and the sewage was flushed directly upon the stone. On June 1, the perforated pans were replaced under the tipping basins, that on Filter No. 135 being placed 14 inches above the surface of the material and that on Filter No. 136 being placed directly upon the material, the openings on the side of Filter No. 135 closed, and a large number of openings made near the bottom of this filter. Operating the filters in this way, the sewage passing to Filter No. 135 was aerated before reaching the filter surface, but no air entered this deep filter except at its top and bottom; on the other hand, the sewage was passed directly to Filter No. 136 without aeration, but air entered at the sides of the filter as well as at the surface. Applying the sewage to Filter No. 135 in the way stated, as good purification results were obtained as with Filter No. 136, having side aeration. It had been proved in former years that direct applications of sewage to the surface of these filters without side aeration was not successful, owing to the exhaustion of oxygen within the filter and the accumulation of nitrogen, $CO_2$, etc. From December 1 to April 7, the filters were operated six days each week, and after April 8 they received sewage seven days a week. Filter No. 135 was operated at a rate of 1,500,000 gallons per acre throughout the year, and Filter No. 136 was




BROKEN STONE. — FILTERS NOS. 135 AND 136.

View of Sprinkling Filter No. 222.

operated at a rate of 2,500,000 gallons per acre from December 1 to May 30, and at a rate of 1,500,000 gallons per acre from June 1 to September 30, when the rate was again increased to 2,500,000 gallons per acre. From December 1 until August 10, regular sewage was applied to both filters, but beginning August 11 both began to receive settled sewage.

### *Filters Nos. 233 and 235.*

Filters Nos. 233 and 235, constructed of clinker, were first put into operation Jan. 1, 1904. These filters contain 69 inches in depth of material. The pieces of clinker in Filter No. 233 vary in size from 3/4 inch to 1 3/4 inches, while in Filter No. 235 they vary from 1/4 inch to 3/4 inch in diameter. Both filters were operated at a rate of 1,000,000 gallons per acre daily from December 1 to September 30. On October 1, the rates were increased to 1,500,000 gallons per acre daily. Regular sewage was applied until August 10, after which settled sewage was applied. The effluent from the filter containing the finer material continued to be the better throughout the year, although at times the effluent from the coarser material was nearly as good.

### *Filters Nos. 247 and 248.*

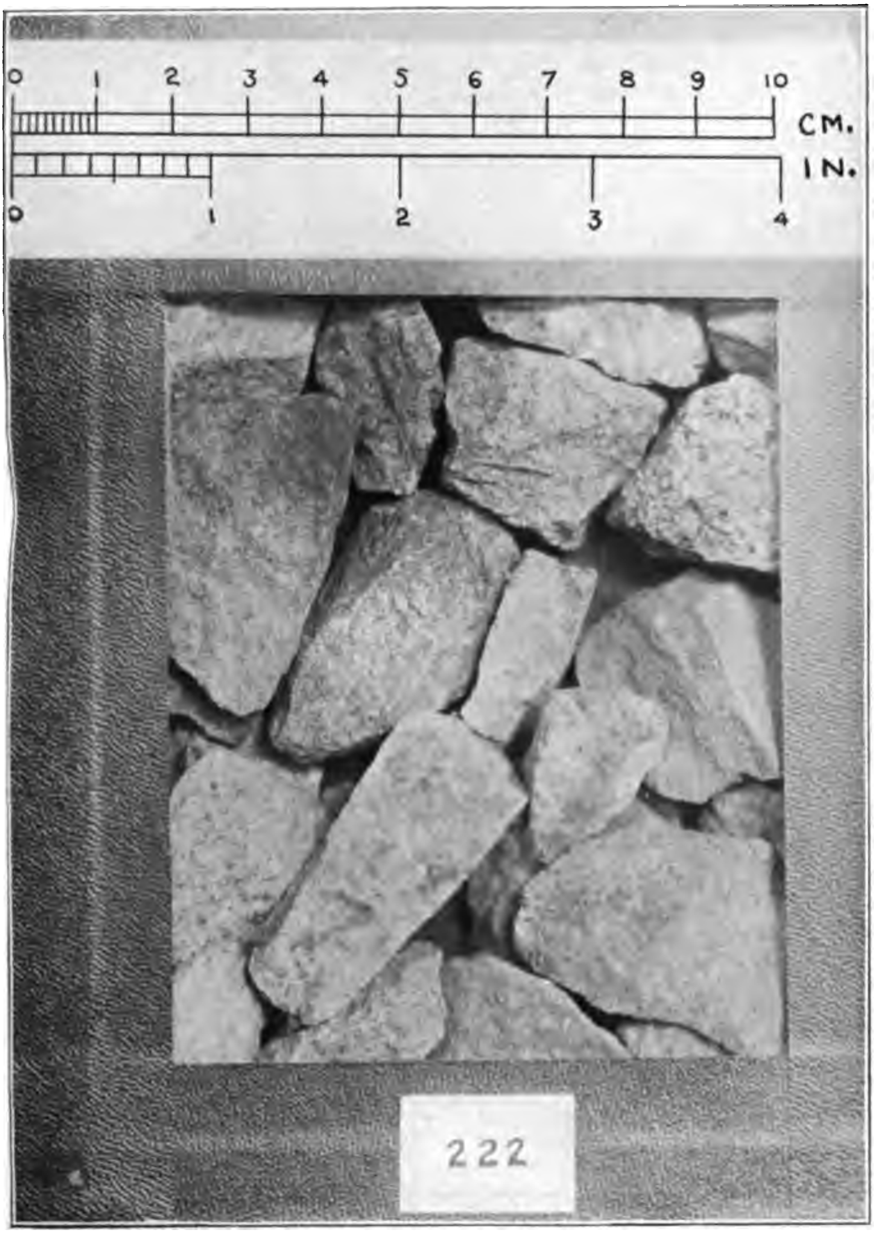
Filters Nos. 247 and 248 are constructed of the same grade of material as Filters Nos. 135 and 136, Filter No. 247 containing about 5 feet and Filter No. 248 about 8 feet. They were first put into operation May 16, 1904. From December 10 to February 28, they were operated with station sewage, at a rate of about 1,500,000 gallons per acre daily. On March 1, the rates were reduced to 1,000,000, and this rate was continued until October 1, when it was increased to 2,000,000 gallons per acre daily. Beginning August 11, and continuing throughout the remainder of the year, the filters were flooded with settled sewage. From January 30 to April 30, varying amounts of strong soap solution were mixed with the sewage applied. The material in No. 247 became so clogged that on March 3 and 17 it was necessary to rake the surface 3 inches deep. No relief being obtained by this treatment, it was allowed to rest from April 2 to 7, inclusive, and, as it still refused to pass the required amount of sewage, on April 11 the material was removed, washed and replaced as before. After this time no trouble was experienced with clogging, and no appreciable amount of clogging was noticed throughout the year in the other filter.

### *Filter No. 222.*

During the early part of April, Filter No. 222, 1/200 of an acre in area, and located in Andover, was rebuilt, all the stone being removed,

6 inches of cobblestones placed over Akron pipe underdrains, and the two grades of broken stone previously used in the filter were mixed and replaced, sufficient new stone of the same size being placed thereon to make a depth of 7 feet of filtering material over the cobblestone underdrains, the surface of the filtering material being about 1 foot higher in the center than on the edge. Beginning April 11, sewage was applied at a rate of 1,000,000 gallons per acre daily, by means of a large tipping basin. On June 2, the tipping basin was removed, the surface of the filter levelled and the rate increased to 2,000,000 gallons per acre daily, a new form of sewage distribution system being installed as follows: —

At one side of the filter was placed an automatic flush tank, into which a small stream of sewage is kept flowing continuously; and when full the tank empties itself through a siphon into a grid containing seven orifices ½ inch in diameter. The top of this tank is 41 inches and the bottom 8 inches above the outlets. One inch below each outlet, and located 12 inches above the surface of the filtering material, were placed dash plates, each 2 inches in diameter, with the outer edge turned up at an angle of 45 degrees, making a slight rim about ¼ inch wide. As the sewage flows from the flush tank through the grid and outlets, it strikes upon the dash plates and is thrown out in a thin sheet, like an umbrella, and breaks into a spray at the outer edge, covering a circle about 5 feet in diameter. As the tank empties, the head operating on the outlets is gradually reduced, and the circle covered by the sewage becomes more and more contracted, until finally, when the tank has emptied, the whole circle has received sewage. The automatic flush tank is of such size that, with the filter operating at a rate of 2,000,000 gallons per acre daily, it will flush about once in nine minutes, about two minutes being required for the tank to empty itself through the seven half-inch outlets. By this method the sewage is distributed over the filter much more uniformly than by the earlier methods, about 90 per cent. of the surface being sprinkled each time the flush tank operates, while in addition the sewage is very thoroughly aerated before it reaches the stones. It has been necessary to clean out the outlets and the smaller pipes of the grid at intervals, owing to the accumulation of growths. On July 27, a considerable growth had accumulated on that portion of the surface of the filter which was wetted by the sewage, and on this date and again on July 30 a strong solution of copper sulphate was applied to the filter by placing the salt in the flush tank, where it was dissolved. This effectually destroyed the growth on the surface of the bed, and no further trouble was experienced. The effluent of this filter is not of such good quality as those of others of similar material and rate operated at the experiment station.




BROKEN STONE.—FILTER NO. 222.

MATERIAL IN FILTER NO. 233 AFTER A PERIOD OF USE.

## *Effluent of Filter No. 247.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily Six Days per Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Albuminoid. | | | | | | | |
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total. | In Solution. | | | Nitrates. | Nitrites. | | |
| **1905.** December, . | 1,519,000 | 38 | 56 | 13.5 | 1.00 | 0.2600 | 0.2340 | .1720 | 0.5037 | 6.70 | 0.02 | .0000 | 2.96 | 525,000 |
| **1906.** January, . | 1,473,000 | 39 | - | 14.5 | 1.01 | 2.6250 | 0.3740 | .2420 | 0.6629 | 7.60 | 0.05 | .0000 | 3.22 | 239,000 |
| February, . | 1,488,000 | 38 | - | 14.5 | 1.10 | 2.2000 | 0.3615 | .2060 | 0.6880 | 6.25 | 0.04 | .0120 | 2.97 | 128,000 |
| March, . . | 1,000,000 | 39 | - | 18.0 | 1.11 | 3.6438 | 0.3875 | .2340 | 0.7737 | 9.25 | 0.05 | .0000 | 4.30 | 187,000 |
| April, . . | 472,000 | 44 | - | 8.0 | 0.80 | 2.6000 | 0.3950 | .3780 | 0.9120 | 10.30 | 0.26 | .2800 | - | 123,800 |
| May, . . | 964,000 | 56 | - | - | 1.10 | 3.1250 | 0.6950 | .4750 | 1.2036 | 14.70 | 1.55 | .0080 | 2.54 | 77,300 |
| June, . . | 731,000 | 61 | - | - | 0.60 | 2.1500 | 0.4480 | .2000 | 0.9430 | 12.30 | 1.55 | .0100 | 3.14 | 153,500 |
| July, . . | 988,000 | 70 | - | - | 0.61 | 2.4000 | 0.7100 | .3040 | 1.2432 | 15.30 | 2.08 | .0240 | 4.52 | 27,750 |
| August, . | 985,000 | 73 | - | - | 0.61 | 1.5750 | 0.3500 | .1940 | 0.6264 | 18.00 | 1.97 | .0080 | 4.49 | 185,500 |
| September, . | 997,000 | 67 | - | - | 0.70 | 3.4000 | 0.4050 | .2920 | 0.6856 | 17.10 | 1.13 | .0060 | 3.39 | 69,800 |
| October, . | 1,993,000 | 59 | - | - | 0.80 | 2.3125 | 0.5600 | .2640 | 0.8880 | 14.80 | 0.58 | .0070 | 3.71 | 243,600 |
| November, . | 2,000,000 | 54 | - | - | 0.60 | 3.1000 | 0.6500 | .4120 | 1.3612 | 14.30 | 0.54 | .0050 | 2.55 | 266,300 |
| Average, . | 1,218,000 | 53 | - | 13.7 | 0.84 | 2.4498 | 0.4642 | .2811 | 0.8743 | 12.22 | 0.82 | .0300 | 3.44 | 185,500 |

## *Effluent of Filter No. 248.*

| Date. | Quantity Applied. | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total. | In Solution. | Kjeldahl Nitrogen. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** December, . | 1,524,000 | 38 | 50 | 12.5 | 0.80 | 2.2438 | 0.4110 | .1560 | 1.1018 | 6.05 | 0.53 | .0040 | 4.00 | 402,000 |
| **1905.** January, . | 1,522,000 | 39 | - | 21.5 | 0.80 | 1.3700 | 0.9845 | .2100 | 1.7598 | 7.40 | 2.44 | .0025 | 5.62 | 95,250 |
| February, . | 1,500,000 | 38 | - | 13.5 | 0.90 | 0.8500 | 0.9475 | .2750 | 1.8015 | 6.10 | 1.94 | .3515 | 5.40 | 59,800 |
| March, . . | 1,000,000 | 39 | - | 19.0 | 1.05 | 0.9875 | 1.3675 | .4640 | 3.1450 | 7.70 | 1.87 | .0030 | 8.56 | 28,800 |
| April, . . | 1,000,000 | 44 | - | 18.0 | 1.00 | 1.1500 | 1.2650 | .2940 | 2.1720 | 9.25 | 2.28 | .0150 | 6.34 | 31,500 |
| May, . . | 1,011,000 | 56 | - | - | 0.90 | 2.1500 | 1.5100 | .2560 | 2.6570 | 12.90 | 3.23 | .0060 | 5.89 | 145,000 |
| June, . . | 1,010,000 | 61 | - | - | 0.85 | 2.4800 | 0.8000 | .1760 | 1.4474 | 13.30 | 1.80 | .0090 | 6.04 | 43,800 |
| July, . . | 1,000,000 | 70 | - | - | 0.65 | 2.1500 | 0.4000 | .2440 | 0.6168 | 17.30 | 2.00 | .0120 | 3.49 | 30,500 |
| August, . | 1,011,000 | 73 | - | 4.0 | 0.75 | 1.0000 | 0.2550 | .1960 | 0.5820 | 17.50 | 1.59 | .0060 | 2.51 | 138,500 |
| September, . | 984,000 | 67 | - | 3.0 | 0.80 | 1.7000 | 0.3750 | .2720 | 0.6988 | 17.10 | 1.76 | .0040 | 2.68 | 25,700 |
| October, . | 2,000,000 | 59 | - | 4.0 | 0.80 | 1.8750 | 0.3900 | .2000 | 0.6264 | 14.70 | 1.79 | .0120 | 3.27 | 38,100 |
| November, . | 2,000,000 | 54 | - | 3.0 | 0.55 | 2.1000 | 0.3100 | .2120 | 0.6740 | 14.20 | 1.87 | .0110 | 2.51 | 53,000 |
| Average, . | 1,297,000 | 53 | - | 10.9 | 0.82 | 1.6672 | 0.7471 | .2463 | 1.4402 | 11.96 | 1.88 | .0363 | 4.69 | 91,000 |

### *Effluent of Filter No. 222.*

[Parts per 100,000.]

| Date. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | | | |
| April, | 0.1 | – | 0.7200 | .1320 | .1240 | – | 2.50 | .19 | .0380 | 0.92 | – |
| May, | – | .40 | 1.2400 | .2520 | .1520 | .4157 | 4.25 | .58 | .0024 | 1.20 | 34.2 |
| June, | – | .21 | 0.6140 | .0820 | .0696 | .1397 | 3.79 | .64 | .0074 | 0.68 | 25.3 |
| July, | – | .35 | 0.8575 | .1125 | .0885 | .1957 | 5.35 | .27 | .0085 | 0.77 | 18.0 |
| August, | – | .47 | 1.3480 | .1352 | .1108 | .2125 | 6.78 | .20 | .0148 | 0.81 | 11.8 |
| September, | 2.1 | .75 | 4.2062 | .2338 | .2030 | .3485 | 9.82 | .07 | .0020 | 1.57 | 1.9 |
| October, | 2.0 | .77 | 6.1500 | .2467 | .2187 | .3865 | 9.63 | .02 | .0020 | 2.56 | 2.8 |
| November, | 1.1 | .68 | 3.5300 | .2618 | .2250 | .3860 | 7.95 | .04 | .0025 | 1.56 | 10.0 |
| Average, | 1.3 | .52 | 2.3332 | .1820 | .1490 | .2978 | 6.26 | .25 | .0097 | 1.26 | 14.1 |

## Sprinkling Filter Summary.

### *Table showing Rates and Analytical Results from 1892 to 1906, inclusive.*

### *Filter No. 15 B.*

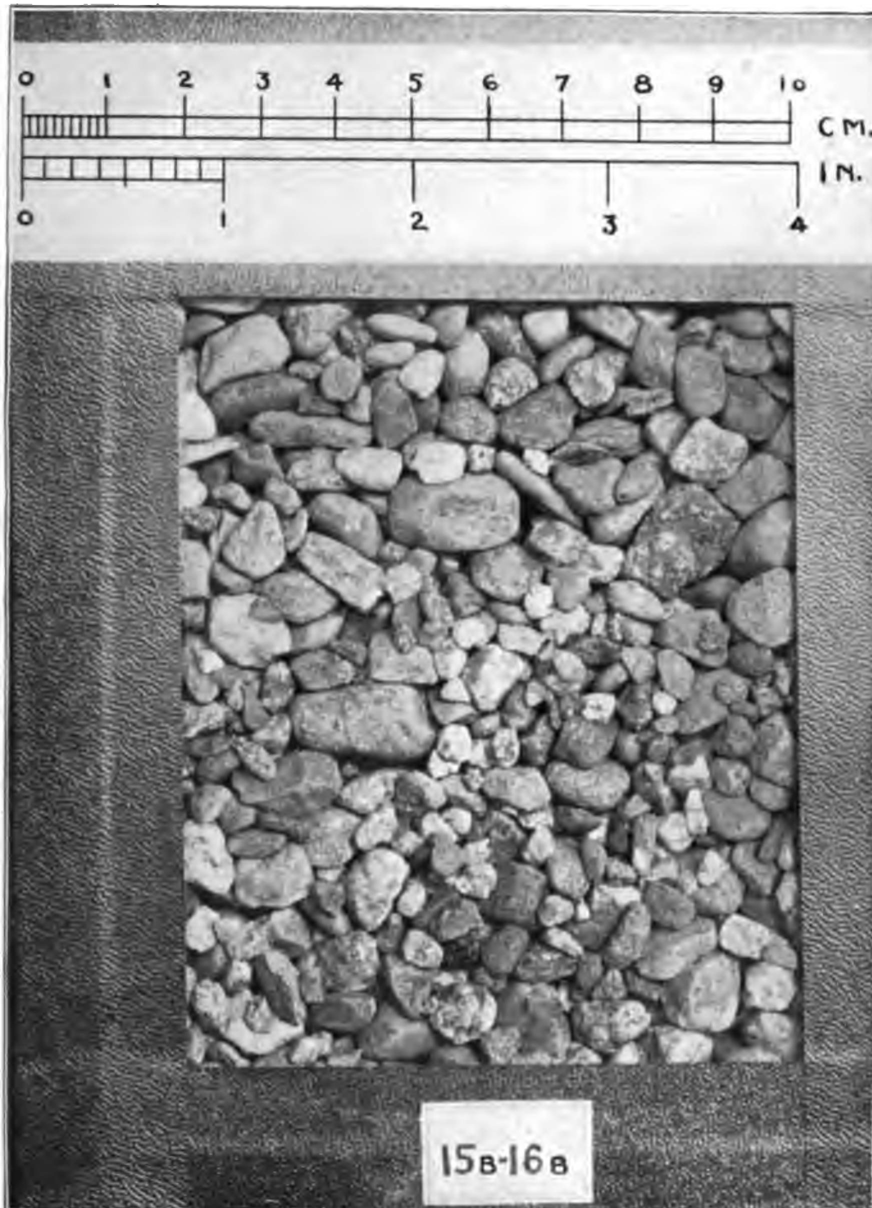
[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Color. | Ammonia. Free. | Ammonia. Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|
| 1892,[1] | 206,000 | .99 | 0.5273 | .1296 | 8.34 | 0.5584 | .0483 | 0.74 |
| 1893, | 405,000 | .59 | 0.6365 | .1483 | 8.47 | 0.9427 | .0204 | 0.82 |
| 1894, | 474,000 | .75 | 1.0628 | .2793 | 7.75 | 1.2450 | .0327 | 1.65 |
| 1895, | 448,800 | .55 | 0.9712 | .1714 | 12.21 | 1.8900 | .0675 | 1.22 |
| 1896, | 354,900 | .50 | 0.6571 | .1349 | 9.66 | 2.5000 | .0117 | 0.72 |
| 1897, | 355,000 | .50 | 0.6797 | .1135 | 8.30 | 1.6700 | .0070 | 0.64 |
| Average, | 374,000 | .65 | 0.7641 | .1620 | 9.12 | 1.4677 | .0318 | 0.96 |

### *Filter No. 16 B.*

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Color. | Ammonia. Free. | Ammonia. Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|
| 1892,[1] | 206,000 | .93 | 0.4823 | .1209 | 8.23 | 0.4772 | .0524 | 0.72 |
| 1893, | 432,000 | .55 | 0.5416 | .1561 | 8.58 | 1.0338 | .0761 | 0.86 |
| 1894, | 463,000 | .61 | 1.0000 | .1797 | 7.74 | 1.3817 | .0193 | 1.07 |
| 1895, | 465,300 | .44 | 0.7402 | .1560 | 11.87 | 1.3900 | .0431 | 1.02 |
| 1896, | 315,600 | .90 | 1.3575 | .2106 | 9.65 | 1.5000 | .0107 | 1.25 |
| 1897, | 323,000 | .63 | 1.0917 | .2669 | 7.90 | 1.9700 | .0112 | 1.28 |
| Average, | 367,400 | .68 | 0.8689 | .1817 | 8.99 | 1.2921 | .0255 | 1.03 |

[1] Five months.




GRAVEL.—FILTERS NOS. 15B AND 16B.

*Table showing Rates and Analytical Results from 1892 to 1906, inclusive*—Continued.

*Filter No. 117.*

[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Color. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | | Nitrates. | Nitrites. | |
| | | | | Total. | In Solution. | | | | |
| 1899 (May-Nov.), | 1,897,000 | .42 | 0.7265 | .0963 | - | 5.96 | 1.88 | .1247 | 1.09 |

*Filter No. 134.*

| Year. | Quantity Applied. | Color. | Free. | Total. | In Solution. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|
| 1899 (Nov.-Dec.), | 1,000,000 | - | 4.8000 | .1820 | - | 8.64 | 0.09 | .0112 | 1.72 |
| 1900, | 1,329,100 | .58 | 2.4271 | .1179 | .0974 | 9.59 | 1.67 | .0295 | 0.97 |
| 1901, | 1,131,200 | .72 | 2.8398 | .1425 | .0983 | 11.13 | 1.61 | .0141 | 1.10 |

*Filter No. 131.*

| Year. | Quantity Applied. | Color. | Free. | Total. | In Solution. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|
| 1899 (Sept.-Dec.), | 1,735,000 | .52 | 2.8100 | .1067 | - | 8.79 | 0.49 | .0133 | 0.95 |
| 1900, | 864,200 | .69 | 2.4400 | .1240 | .0775 | 7.03 | 0.61 | .0072 | 0.99 |

*Filter No. 189.*

| Year. | Quantity Applied. | Color. | Free. | Total. | In Solution. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|
| 1902 (May-Dec.), | 2,301,700 | .90 | 2.3134 | .3569 | .1515 | 10.64 | 0.96 | .0537 | 2.21 |
| 1903, | 2,542,800 | .94 | 2.2450 | .3879 | .1535 | 10.27 | 0.98 | .0229 | 2.65 |
| 1904 (Jan.-April), | 1,451,500 | .86 | 3.0729 | .6200 | .2158 | 7.40 | 2.13 | .0222 | 2.75 |

*Effluent of Filter No. 196.*

[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Color. | Ammonia. | | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | | | | Nitrates. | Nitrites. | |
| | | | | Total. | In Solution. | In Suspension. | | | | | |
| 1906 (Jan.-Sept.), | 1,142,600 | .69 | 2.4760 | .2926 | .1170 | .1756 | - | 9.52 | 0.61 | .0202 | 2.06 |

*Effluent of Filter No. 233.*

| Year. | Quantity Applied. | Color. | Free. | Total. | In Solution. | In Suspension. | Kjeldahl Nitrogen. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904, | 855,000 | .77 | 2.7515 | .3247 | .1755 | .1492 | - | 10.09 | 1.24 | .0877 | 2.18 |
| 1905, | 919,400 | .98 | 1.7686 | .3147 | .1527 | .1620 | 0.6718 | 8.76 | 1.39 | .0117 | 2.22 |
| 1906, | 1,087,200 | .57 | 1.3540 | .3690 | .1798 | .1892 | 0.6708 | 11.78 | 1.87 | .0453 | 2.68 |

*Table showing Rates and Analytical Results from 1892 to 1906, inclusive* — Concluded.

*Effluent of Filter No. 234.*

[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Color. | Ammonia. | | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | | | | Nitrates. | Nitrites. | |
| | | | | Total. | In Solution. | In Suspension. | | | | | |
| 1904, | 949,000 | .88 | 3.4225 | .4707 | .2431 | .2276 | – | 10.16 | 0.78 | .0768 | 2.80 |
| 1905,[1] | 1,160,000 | .65 | 1.9500 | .4100 | .2880 | .1220 | 1.0707 | 9.09 | 0.02 | .0010 | 3.86 |
| *Effluent of Filter No. 235.* | | | | | | | | | | | |
| 1904, | 896,500 | .57 | 1.3169 | .3051 | .1312 | .1739 | – | 11.79 | 2.20 | .0791 | 1.89 |
| 1905, | 911,500 | .89 | 1.2044 | .2300 | .1046 | .1254 | 0.4453 | 8.21 | 1.71 | .0058 | 1.84 |
| 1906, | 1,085,200 | .55 | 1.0399 | .3398 | .1435 | .1963 | 0.6705 | 11.93 | 2.23 | .0287 | 2.87 |
| *Effluent of Filter No. 236.* | | | | | | | | | | | |
| 1904, | 908,900 | .77 | 3.5721 | .4411 | .2254 | .2157 | – | 11.18 | 0.50 | .0127 | 2.48 |
| 1905,[1] | 840,000 | .73 | 1.9563 | .2950 | .2120 | .0830 | 0.6155 | 8.56 | 0.02 | .0005 | 3.00 |

[1] One month, January.

*Effluent of Filter No. 247.*

[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Turbidity. | Color. | Ammonia. | | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | | | | Nitrates. | Nitrites. | |
| | | | | | Total. | In Solution. | In Suspension. | | | | | |
| 1904 (May-Dec.), | 925,500 | 8.6 | 0.68 | 2.8100 | .3075 | .1931 | .1144 | – | 12.01 | 0.52 | .0216 | 1.50 |
| 1905, | 1,368,200 | 8.5 | 1.68 | 2.2632 | .3737 | .1935 | .1802 | 0.7684 | 8.84 | 0.49 | .0091 | 2.52 |
| 1906, | 1,218,000 | 13.7 | 0.85 | 2.4493 | .4642 | .2811 | .1831 | 0.8743 | 12.22 | 0.82 | .0300 | 3.44 |
| *Effluent of Filter No. 248.* | | | | | | | | | | | | |
| 1904 (May-Dec.), | 963,400 | 10.0 | 0.78 | 4.0924 | .5775 | .2813 | .2962 | – | 11.23 | 2.12 | .0572 | 2.81 |
| 1905, | 1,365,800 | 8.7 | 1.39 | 1.9180 | .3666 | .1816 | .1850 | 0.8537 | 7.78 | 1.14 | .0108 | 2.71 |
| 1906, | 1,297,000 | 10.9 | 0.82 | 1.6672 | .7471 | .2463 | .5008 | 1.4402 | 11.96 | 1.88 | .0863 | 4.69 |

### *Nitrogen Tables.*

#### *Filter No. 15 B — Regular Sewage applied.*

[Parts per 100,000.]

| Year. | Quantity Applied. Gallons per Acre Daily for Six Days in a Week. | Total Nitrogen in Applied Sewage. | Nitrogen in Effluent. Total. | Nitrogen in Effluent. Oxidised. | Nitrogen in Effluent. Unoxidised. | Lost. | Per Cent. of Applied Nitrogen. In Effluent. Oxidised. | Per Cent. of Applied Nitrogen. In Effluent. Unoxidised. | Per Cent. of Applied Nitrogen. Lost. |
|---|---|---|---|---|---|---|---|---|---|
| 1892,[1] . . . . . | 206,000 | 3.63 | 0.92 | 0.26 | 0.66 | 2.71 | 7.2 | 18.2 | 74.6 |
| 1893, . . . . . | 405,000 | 3.50 | 1.82 | 0.96 | 0.86 | 1.68 | 27.4 | 24.6 | 48.0 |
| 1894, . . . . . | 474,000 | 3.29 | 1.73 | 1.28 | 0.45 | 1.56 | 38.9 | 13.7 | 47.4 |
| 1895, . . . . . | 449,000 | 5.37 | 3.22 | 2.03 | 1.19 | 2.15 | 37.8 | 22.2 | 40.0 |
| 1896, . . . . . | 354,900 | 4.95 | 3.31 | 2.51 | 0.80 | 1.64 | 50.7 | 16.2 | 33.1 |
| 1897, . . . . . | 355,000 | 4.78 | 2.46 | 1.68 | 0.78 | 2.32 | 35.1 | 16.3 | 48.6 |
| Average, . . | 374,000 | 4.25 | 2.24 | 1.45 | 0.79 | 2.01 | 34.1 | 18.8 | 47.1 |

#### *Filter No. 16 B — Regular Sewage applied.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1892,[1] . . . . . | 206,000 | 3.63 | 0.49 | 0.22 | 0.27 | 3.14 | 6.1 | 7.4 | 86.5 |
| 1893, . . . . . | 432,000 | 3.50 | 1.81 | 1.08 | 0.73 | 1.69 | 30.8 | 20.9 | 48.3 |
| 1894, . . . . . | 463,000 | 3.29 | 2.51 | 1.33 | 1.18 | 0.78 | 40.4 | 35.8 | 20.8 |
| 1895, . . . . . | 465,000 | 5.37 | 2.35 | 1.43 | 0.92 | 3.02 | 26.6 | 17.1 | 56.3 |
| 1896, . . . . . | 315,600 | 4.95 | 3.03 | 1.51 | 1.52 | 1.92 | 30.5 | 30.7 | 38.8 |
| 1897, . . . . . | 323,000 | 4.78 | 3.40 | 1.98 | 1.42 | 1.38 | 41.4 | 29.7 | 28.9 |
| Average, . . | 367,400 | 4.25 | 2.28 | 1.27 | 1.01 | 1.97 | 29.8 | 23.8 | 46.4 |

#### *Filter No. 117.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1899 (May-Nov.), . | 1,897,000 | 3.86 | 2.77 | 2.00 | 0.77 | 1.09 | 52 | 20 | 28 |

#### *Filter No. 131.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1899 (Sept.-Dec.), . | 1,735,000 | 5.17 | 3.00 | 0.50 | 2.50 | 2.17 | 10 | 48 | 42 |
| 1900, . . . . . | 864,200 | 3.81 | 2.84 | 0.62 | 2.22 | 0.97 | 16 | 58 | 26 |

#### *Filter No. 134.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1899 (Nov. and Dec.), . | 1,000,000 | 4.94 | 4.37 | 0.10 | 4.27 | 0.57 | 2 | 87 | 11 |
| 1900, . . . . . | 1,329,100 | 4.34 | 3.91 | 1.70 | 2.21 | 0.43 | 39 | 51 | 10 |
| 1901, . . . . . | 1,131,200 | 4.57 | 4.21 | 1.62 | 2.59 | 0.36 | 35 | 57 | 8 |

[1] Five months.

## *Nitrogen Tables* — Continued.

### *Filter No. 189.*

[Parts per 100,000.]

| Year. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Total Nitrogen in Applied Sewage. | Nitrogen in Effluent. | | | Lost. | Per Cent. of Applied Nitrogen. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | In Effluent. | | |
| | | | Total. | Oxidized. | Unoxidized. | | Oxidized. | Unoxidized. | Lost. |
| 1902 (May-Dec.), | 2,301,700 | 4.31 | 3.60 | 1.03 | 2.57 | 0.71 | 24 | 60 | 16 |
| 1903, | 2,542,800 | 4.81 | 3.54 | 1.00 | 2.54 | 1.27 | 21 | 53 | 26 |
| 1904 (Jan.-April), | 1,451,500 | 8.26 | 5.79 | 2.15 | 3.64 | 2.47 | 26 | 44 | 30 |
| ***Filter No. 196.*** | | | | | | | | | |
| 1903 (Jan.-Sept.), | 1,142,600 | 3.72 | 3.19 | 0.63 | 2.56 | 0.53 | 17 | 69 | 14 |
| ***Filter No. 233.*** | | | | | | | | | |
| 1904, | 885,000 | 8.80 | 4.12 | 1.28 | 2.84 | 4.68 | 15 | 32 | 53 |
| 1905, | 919,400 | 5.95 | 4.33 | 1.40 | 2.93 | 1.62 | 24 | 49 | 27 |
| 1906, | - | - | - | - | - | - | - | - | - |
| ***Filter No. 234.*** | | | | | | | | | |
| 1904, | 949,000 | 8.80 | 4.46 | 0.81 | 3.65 | 4.34 | 9 | 42 | 49 |
| 1905,[1] | 1,160,000 | 5.49 | 3.98 | 0.02 | 3.96 | 1.51 | 1 | 72 | 27 |
| ***Filter No. 235.*** | | | | | | | | | |
| 1904, | 896,500 | 8.80 | 3.91 | 2.28 | 1.63 | 4.89 | 26 | 18 | 56 |
| 1905, | 911,500 | 4.87 | 3.68 | 1.72 | 1.96 | 1.19 | 36 | 40 | 24 |
| 1906, | - | - | - | - | - | - | - | - | - |
| ***Filter No. 236.*** | | | | | | | | | |
| 1904, | 908,900 | 8.80 | 4.24 | 0.51 | 3.73 | 4.56 | 6 | 42 | 52 |
| 1905,[1] | 840,000 | 5.49 | 2.98 | 0.02 | 2.96 | 2.51 | 0 | 54 | 46 |
| ***Filter No. 247.*** | | | | | | | | | |
| 1904 (May-Dec.), | 925,500 | 9.08 | 3.40 | 0.54 | 2.86 | 5.68 | 6 | 31 | 63 |
| 1905, | 1,368,200 | 4.63 | 4.05 | 0.50 | 3.55 | 0.58 | 11 | 76 | 13 |
| 1906, | - | - | - | - | - | - | - | - | - |

[1] One month.

## *Nitrogen Tables* — Concluded.

### *Filter No. 248.*

[Parts per 100,000.]

| Year. | Quantity Applied. Gallons per Acre Daily for Six Days in a Week. | Total Nitrogen in Applied Sewage. | Nitrogen in Effluent. | | | Lost. | Per Cent. of Applied Nitrogen. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | In Effluent. | | |
| | | | Total. | Oxidized. | Unoxidized. | | Oxidized. | Unoxidized. | Lost. |
| 1904 (May-Dec.), | 963,400 | 9.08 | 6.57 | 2.18 | 4.39 | 2.51 | 24 | 48 | 28 |
| 1905, | 1,365,800 | 5.52 | 4.60 | 1.15 | 3.45 | 0.92 | 21 | 62 | 17 |
| 1906, | - | - | - | - | - | - | - | - | - |

### *Sewage applied to Filter No. 135.*

[Parts per 100,000.]

| Year. | Ammonia. | | | Kjeldahl Nitrogen. | | Chlorine. | Oxygen Consumed. | |
|---|---|---|---|---|---|---|---|---|
| | | Albuminoid. | | | | | | |
| | Free. | Total. | In Solution. | Total. | In Solution. | | | |
| 1900, | 4.09 | .62 | .27 | 1.27 | .55 | 9.02 | 4.31 | Regular sewage. |
| 1901, | 6.41 | .35 | .29 | 0.72 | .59 | 9.70 | 2.08 | Strained sewage. |
| 1902, | 5.31 | .36 | .25 | 0.74 | .51 | 8.50 | 2.12 | |
| 1903, | 4.05 | .39 | .24 | 0.80 | .49 | 9.96 | 2.90 | |
| 1904, | 5.15 | .95 | .47 | 1.83 | .87 | 12.31 | 4.86 | Regular sewage. |
| 1905, | 2.98 | .47 | .25 | 0.92 | .47 | 8.94 | 3.35 | |
| 1906, | 4.54 | .67 | .38 | 1.18 | .63 | 12.99 | 4.57 | |
| Average, | 4.65 | .54 | .31 | 1.07 | .59 | 10.20 | 3.46 | |

### *Sewage applied to Filter No. 136.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1900, | 4.67 | .33 | .22 | 0.68 | .45 | 9.74 | 2.45 | Septic sewage. |
| 1901, | 5.98 | .39 | .29 | 0.80 | .59 | 8.73 | 2.58 | |
| 1902, | 4.52 | .43 | .27 | 0.88 | .55 | 11.25 | 2.85 | |
| 1903, | 3.80 | .35 | .22 | 0.72 | .45 | 9.91 | 2.93 | |
| 1904, | 5.15 | .95 | .47 | 1.83 | .87 | 12.31 | 4.86 | Regular sewage. |
| 1905, | 2.94 | .43 | .25 | 0.82 | .47 | 9.23 | 3.26 | |
| 1906, | 4.46 | .64 | .37 | 1.19 | .66 | 13.03 | 4.60 | |
| Average, | 4.50 | .50 | .30 | 0.99 | .58 | 10.60 | 3.36 | |

*Yearly Average Analyses of the Effluents of Filters Nos 135 and 136.*

*Filter No. 135.*

[Parts per 100,000.]

| Year. | Quantity Applied. Gallons per Acre Daily. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1899-1900,[1] . . . | 899,900 | - | 1.12 | 3.4353 | .1606 | .1049 | .2897 | 7.64 | 0.23 | .0045 | 1.42 |
| 1900,[2] . . . . | 1,804,900 | - | 0.64 | 2.5212 | .2080 | .1448 | .3752 | 10.54 | 0.45 | .0181 | 1.33 |
| 1901, . . . . | 1,406,900 | - | 0.81 | 3.1645 | .2228 | .1353 | .4019 | 9.44 | 2.40 | .0132 | 1.57 |
| 1902, . . . . | 1,817,400 | - | 0.52 | 1.7452 | .1392 | .0656 | .2510 | 8.61 | 2.76 | .0071 | 1.08 |
| 1903, . . . . | 2,398,600 | - | 0.67 | 1.6000 | .1473 | .0933 | .2658 | 9.02 | 1.47 | .0107 | 1.37 |
| 1904, . . . . | 1,150,400 | 8.0 | 0.57 | 0.7047 | .2889 | .1143 | .5212 | 11.17 | 2.95 | .0064 | 2.30 |
| 1905, . . . . | 1,304,000 | 4.5 | 0.86 | 0.7173 | .2158 | .1059 | .3563 | 8.08 | 3.47 | .0054 | 1.69 |
| 1906, . . . . | 1,469,100 | 4.7 | 0.50 | 0.4437 | .2335 | .1422 | .4128 | 12.60 | 4.36 | .0061 | 2.03 |
| Average, . . | 1,531,400 | 5.7 | 0.71 | 1.7915 | .2020 | .1158 | .3592 | 9.64 | 2.26 | .0083 | 1.59 |

*Filter No. 136.*

| Year. | Quantity Applied. Gallons per Acre Daily. | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. In Solution. | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1899-1900,[1] . . . | 747,600 | - | 0.58 | 3.4273 | .1646 | .1066 | .2969 | 7.58 | 0.16 | .0170 | 1.20 |
| 1900,[2] . . . . | 1,094,700 | - | 0.58 | 2.2230 | .1245 | .1181 | .2246 | 10.41 | 2.20 | .0179 | 1.09 |
| 1901, . . . . | 1,402,700 | - | 0.82 | 3.4153 | .2331 | .1344 | .4204 | 8.62 | 2.00 | .0086 | 1.67 |
| 1902, . . . . | 1,809,100 | - | 0.60 | 2.3553 | .1930 | .1050 | .3483 | 9.06 | 2.66 | .0091 | 1.36 |
| 1903, . . . . | 2,257,300 | - | 0.66 | 1.6565 | .2161 | .1027 | .3398 | 9.88 | 1.91 | .0089 | 1.84 |
| 1904, . . . . | 1,988,000 | 10.5 | 0.68 | 1.3883 | .3343 | .1509 | .6030 | 11.06 | 2.05 | .0096 | 2.35 |
| 1905, . . . . | 2,082,000 | 6.4 | 1.14 | 1.2855 | .2911 | .1256 | .5161 | 8.29 | 2.19 | .0102 | 2.26 |
| 1906, . . . . | 2,099,200 | 7.5 | 0.58 | 0.8316 | .3481 | .1952 | .6452 | 12.73 | 3.65 | .0094 | 2.83 |
| Average, . . | 1,667,600 | 8.1 | 0.70 | 2.0728 | .2381 | .1292 | .4305 | 9.70 | 2.10 | .0113 | 1.83 |

[1] November 28 to April 15. [2] April 16 to December 31.

## Double Filtration.

*Sand Filtration of Sprinkling Filter Effluents and Mechanical Filtration of Such Effluents.*

*Filters Nos. 224, 249 and 250.* — Filter No. 224, 1/20000 of an acre in area and constructed of 54 inches in depth of sand of an effective size of 0.27 millimeter, was first put into operation Oct. 1, 1903. It received the effluents from Filters Nos. 135 and 136 after they had passed through

a settling basin. The average rate of operation during 1906 was 573,000 gallons per acre daily. It was very difficult to keep the rate of filtration up to this high figure, owing to the accumulation of organic matter in its upper portion; and in order to do so the filter was raked 3 inches deep thirty-seven times during the year, and dug over 6 inches three times. On Dec. 16, 1906, it was necessary to remove 6 inches in depth of sand from the surface of the filter.

*Filters Nos. 249 and 250.* — Filters Nos. 249 and 250, each $\frac{1}{20000}$ of an acre in area and constructed of sand of an effective size of 0.41 millimeter, were first put into operation May 16, 1904, and have received since that time the effluents of Filters Nos. 135 and 136 after they have passed through a sedimentation basin. The average rate of operation of Filter No. 249 during 1906 was 685,000 gallons, and of Filter No. 250, 755,000 gallons per acre daily. As stated in previous reports, these two filters, besides being used as a study in secondary filtration, are also intended to give information in regard to sand removal. It has been the practice never to dig over Filter No. 249 to a greater depth than 3 inches, and when this upper 3 inches of sand becomes so clogged with organic matter that sewage will not pass through it, it is removed. On the other hand, Filter No. 250 is to be dug over to a greater depth when necessary, and to be kept in operation as long as possible without removal of sand. During 1906, Filter No. 249 was raked to a depth of 3 inches fourteen times; and 3 inches of sand were removed on January 31 and again on August 6. On September 17, 45 inches of sand remained in the filter. Filter No. 250 was raked to a depth of 3 inches ten times during the year, and dug over to a depth of 6 inches on March 4 and to a depth of 12 inches on May 2. On September 17, careful measurements showed that there were about 55 inches of material in the filter.

*Effluent applied to Filters Nos. 224, 249 and 250.*

[Parts per 100,000.]

| | Temperature (Deg. F.) | Appearance. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Color. | Free. | Albuminoid. Total. | Albuminoid. In Solution. | | | Nitrates. | Nitrites. | | |
| Average, | 59 | 3.6 | .63 | 1.3371 | .1634 | .1083 | .2852 | 12.58 | 1.96 | .0829 | 1.42 | 359,400 |

## *Effluent of Filter No. 224.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Total Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, . | 477,000 | 54 | 52 | 0.0 | .22 | .0145 | .0208 | .0498 | 7.10 | 2.56 | .0000 | .33 | 15,400 |
| **1906.** | | | | | | | | | | | | | |
| January, . . | 600,000 | 58 | 52 | 0.0 | .17 | .0704 | .0269 | .0562 | 12.90 | 2.56 | .0001 | .35 | 350 |
| February, . | 550,000 | 52 | 51 | 0.0 | .16 | .0420 | .0240 | .0480 | 2.40 | 1.45 | .0000 | .32 | 300 |
| March, . . | 568,000 | 55 | 58 | 0.0 | .18 | .1585 | .0340 | .0608 | 8.60 | 2.69 | .0000 | .38 | 140 |
| April, . . | 592,000 | 57 | 57 | 0.1— | .20 | .0808 | .0433 | .0337 | 8.40 | 2.94 | .0002 | .40 | 375 |
| May, . . | 600,000 | 60 | 57 | 0.1 | .27 | .1445 | .0505 | - | 17.60 | 2.94 | .0002 | .51 | 3,600 |
| June, . . | 546,200 | 62 | 62 | 0.1 | .19 | .0544 | .0386 | - | 13.05 | 3.32 | .0001 | .45 | 460 |
| July, . . | 592,000 | 68 | 70 | 0.2 | .20 | .0930 | .0415 | - | 15.10 | 2.94 | .0002 | .48 | 930 |
| August, . . | 600,000 | 69 | 70 | 0.1 | .18 | .0039 | .0358 | - | 19.15 | 2.74 | .0001 | .39 | 1,613 |
| September, . | 584,000 | 65 | 65 | 0.1— | .20 | .0137 | .0302 | - | 12.55 | 3.15 | .0003 | .42 | 1,700 |
| October, . . | 600,000 | 61 | 60 | 0.1— | .25 | .0275 | .0425 | - | 14.15 | 3.36 | .0001 | .56 | 410 |
| November, . | 577,000 | 53 | 51 | 0.2 | .43 | .2500 | .0680 | - | 13.20 | 5.04 | .0009 | .73 | 3,900 |
| Average, . | 578,400 | 59 | 58 | 0.0 | .22 | .0794 | .0380 | .0596 | 12.02 | 2.97 | .0001 | .44 | 2,400 |

## *Effluent of Filter No. 249.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, . . | 469,000 | 54 | 53 | 0.0 | .27 | .0056 | .0164 | - | 5.70 | 2.27 | .0000 | .43 | 250 |
| **1906.** | | | | | | | | | | | | | |
| January, . . . | 696,000 | 58 | 52 | 0.1— | .20 | .0222 | .0286 | .0435 | 11.10 | 3.65 | .0000 | .39 | 3,300 |
| February, . . | 788,000 | 52 | 52 | 0.1 | .28 | .0275 | .0305 | .0664 | 2.80 | 1.55 | .0000 | .39 | 3,200 |
| March, . . . | 770,400 | 55 | 54 | 0.5 | .54 | .5800 | .0695 | .1402 | 7.85 | 2.77 | .0008 | .90 | 4,000 |
| April, . . . | 728,000 | 57 | 56 | 0.2 | .22 | .1195 | .0558 | - | 8.95 | 4.20 | .0010 | .41 | 4,200 |
| May, . . . | 748,000 | 60 | 58 | 0.5 | .60 | .7200 | .0930 | - | 20.60 | 4.19 | .0200 | .81 | 172,200 |
| June, . . . | 661,500 | 62 | 64 | 0.2 | .19 | .0236 | .0304 | - | 12.35 | 4.27 | .0003 | .39 | 11,600 |
| July, . . . | 607,700 | 68 | 68 | 0.2 | .35 | .4058 | .0416 | - | 16.05 | 2.66 | .0701 | .55 | 1,450 |
| August, . . . | 726,000 | 69 | 70 | 0.1 | .22 | .0038 | .0258 | - | 19.65 | 3.20 | .0000 | .40 | 4,550 |
| September, . . | 584,000 | 65 | 65 | 0.1 | .20 | .0032 | .0268 | - | 12.05 | 3.07 | .0000 | .33 | 26,700 |
| October, . . . | 785,000 | 61 | 61 | 0.2 | .34 | .0524 | .0446 | - | 14.30 | 4.83 | .0002 | .55 | 14,200 |
| November, . . | 653,800 | 53 | 54 | 0.2 | .38 | .0500 | .0720 | - | 13.20 | 4.79 | .0000 | .85 | 8,000 |
| Average, . . | 684,800 | 59 | 59 | 0.2 | .32 | .1678 | .0463 | .0834 | 12.05 | 3.45 | .0077 | .53 | 21,100 |

*Effluent of Filter No. 250.*

[Parts per 100,000.]

| Date. | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | | Appearance. | | Ammonia. | | Kjeldahl Nitrogen. | Chlorine. | Nitrogen as | | Oxygen Consumed. | Bacteria per Cubic Centimeter. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sewage. | Effluent. | Turbidity. | Color. | Free. | Albuminoid. | | | Nitrates. | Nitrites. | | |
| **1905.** | | | | | | | | | | | | | |
| December, | 800,000 | 54 | 52 | 0.1— | .22 | .0464 | .0622 | .0568 | 6.98 | 2.48 | .0000 | .36 | 2,150 |
| **1906.** | | | | | | | | | | | | | |
| January, | 800,000 | 53 | 52 | 0.1 | .20 | .2012 | .0388 | - | 11.75 | 3.64 | .0002 | .44 | 2,050 |
| February, | 788,000 | 52 | 51 | 0.0 | .18 | .0505 | .0265 | - | 2.40 | 1.70 | .0000 | .33 | 2,950 |
| March, | 792,600 | 55 | 54 | 0.0 | .16 | .2970 | .0465 | .0747 | 8.20 | 3.28 | .0001 | .41 | 900 |
| April, | 784,000 | 57 | 57 | 0.1— | .21 | .2295 | .0500 | .0958 | 9.55 | 3.70 | .0005 | .37 | 2,000 |
| May, | 748,000 | 60 | 61 | 0.5 | .37 | .1610 | .0640 | - | 17.65 | 3.83 | .0001 | .64 | 24,500 |
| June, | 669,200 | 62 | 63 | 0.3 | .22 | .0656 | .0470 | - | 13.05 | 4.00 | .0000 | .47 | 11,200 |
| July, | 800,000 | 68 | 68 | 0.2 | .21 | .0834 | .0474 | - | 14.45 | 3.11 | .0000 | .50 | 7,400 |
| August, | 763,000 | 69 | 70 | 0.3 | .21 | .0629 | .0690 | - | 19.05 | 3.04 | .0000 | .50 | 10,450 |
| September, | 616,000 | 65 | 65 | 0.1 | .22 | .0286 | .0650 | - | 12.40 | 3.11 | .0001 | .51 | 63,300 |
| October, | 798,000 | 61 | 61 | 0.2 | .32 | .0658 | .0468 | - | 14.15 | 4.37 | .0002 | .55 | 2,500 |
| November, | 700,000 | 58 | 51 | 0.3 | .50 | .1480 | .0640 | - | 13.40 | 5.21 | .0000 | .73 | 5,200 |
| Average, | 754,500 | 59 | 59 | 0.2 | .25 | .1175 | .0464 | .0756 | 11.92 | 3.46 | .0001 | .48 | 11,200 |

*Coagulation and Mechanical Filtration of Effluents of Sprinkling Filters.*

*Filter No. 300.* — This filter, 1/80000 of an acre in area, started April 20, 1906, has been operated as a mechanical filter, receiving the settled effluents from Filters Nos. 135, 136, 233, 235, 247 and 248.

The settled effluents from the various trickling filters were mixed in a storage basin, passed thence through an outlet pipe to the bottom of a coagulation and sedimentation tank, where the chemicals were added, then passed upward and overflowed upon the filter, the rate of filtration and the depth of water on the filter being automatically regulated. As is usual with filters of this type, when the filter became clogged to such an extent that water would not pass through at the prescribed rate, the filtering material was washed by passing a strong upward current of clear water through the sand, which was thoroughly agitated at the same time.

At the start the filter contained 24 inches of washed sand having an effective size of 0.71 millimeter, and was operated at a rate of approximately 50,000,000 gallons per acre daily, the applied effluent being

treated with sulphate of alumina in amounts varying between 1.3 and 3.5 grains per gallon.

On May 20, the sand in the filter was removed and replaced by 24 inches of beach sand having an effective size of 0.35 millimeter, following which the filter was operated until August 19 at a 50,000,000-gallon rate. On August 20, the rate was reduced to 25,000,000 gallons per acre daily, at which rate the filter was operated during the remainder of the year.

From May 20, when the filtering material was changed, until August 25, the coagulants employed were copperas and lime in varying amounts. On August 25, samples of a new form of ferrous sulphate, called "sugar sulphate of iron," stated to contain less water of crystallization and more available iron than commercial copperas, and of a similar iron sulphate with which was incorporated a small amount of copper sulphate, were obtained, and thereafter were used as coagulants during alternate weeks until the end of the year.

Analyses of the various coagulants showed that the commercial copperas contained about 55 per cent. available $FeSO_4$, the sugar sulphate of iron contained about 64 per cent. available $FeSO_4$, the copper iron sulphate contained about 63 per cent. available $FeSO_4$, and .2 per cent. of copper equivalent to about ½ per cent. of $CuSO_4$, and the sulphate of alumina contained about 58 per cent. available $Al_2(SO_4)_3$.

The coagulation and sedimentation tank was of such capacity that the period between the addition of coagulants and the time the water reached the filtering material was about two and one-half hours when the filter was operated at a 50,000,000-gallon rate, and about five hours when the filter was operated at a 25,000,000-gallon rate.

*Wash Water.* — Mechanical filter practice requires that filters be washed at a rate of about 6 gallons per square foot, and it usually requires about fifteen minutes to wash a large filter of the usual mechanical filter type. Based on the above figures, the volume of water required to wash Filter No. 300 would have varied between 14 per cent. and 44 per cent., averaging about 28 per cent. of the total volume filtered.

The actual practice in washing this filter was to apply the wash water at about the theoretical rate for a period of five minutes only. An average of twelve determinations of the volume of wash water required by this procedure showed that the actual amount was about 6 per cent. of the total volume filtered, the difference between the theoretical and the actual amount being probably due to the more thorough agitation of the filtering material during the time of washing than would be the case with a large filter agitated mechanically.

*Cost of Chemicals.* — The cost of chemicals in the tables was based upon the following estimated values in large lots: —

| | Per Ton. |
|---|---|
| Sulphate of alumina, | $20 00 |
| Copperas, | 10 00 |
| Sugar sulphate of iron, | 10 00 |
| Copper iron sulphate, | 11 00 |
| Soda ash, | 20 00 |
| Lime, | 6 00 |

The results of chemical analyses indicate that the purification was entirely mechanical, and that no biological action occurred in the filter, as is shown by the fact that the amounts of free ammonia, nitrates and nitrites were practically unchanged.

With sulphate of alumina as a coagulant, no lime or soda ash was required, and an adequate removal of suspended matter was accomplished by the use of 2.5 to 3.5 grains per gallon. The removal of bacteria was not satisfactory, only 83 per cent. of the total bacteria and 92 per cent. of B. coli being eliminated when 3.5 grains were used. It must be remembered that during this period the filtering material was much coarser than was the case later on.

With commercial copperas, without lime, there was no removal of color or turbidity, and only a very small removal of bacteria, even when amounts as large as 8.7 grains per gallon were used. This was undoubtedly due to the fact that while the raw water was sufficiently alkaline to more than compensate for the copperas added, the presence of considerable free and half-bound carbonic acid prevented the reaction from taking place.

When commercial copperas and lime were added, the purification was much more satisfactory, from 90 to 100 per cent. of the turbidity and from 40 to 60 per cent. of the total albuminoid ammonia being removed. The removal of bacteria was less satisfactory, being at all times less than 90 per cent. About 8.5 grains of copperas and about 4 grains of lime per gallon were used during this period.

From August 21 to 24, with 8.5 grains of copperas and 6.0 grains of lime, and with the filter operated at the comparatively low rate of 26,000,000 gallons per acre daily, the removal of color, turbidity and albuminoid ammonia was satisfactory and the removal of bacteria and of B. coli was 98.1 and 99.6 per cent. respectively.

During the periods when the raw water received "sugar sulphate of iron" and lime in the proportion of about 8.0 and 9.0 grains respectively, the removal of turbidity was complete, the removal of color varied from

56 to 65 per cent., the removal of albuminoid ammonia was between 54 and 68 per cent., and the removal of bacteria and of B. coli was about 99 per cent.

During the periods when the copper iron sulphate was used the removal of color and albuminoid ammonia was slightly greater than when the sugar sulphate was used, and the removal of B. coli was practically the same; but the removal of turbidity and of total bacteria was less satisfactory.

The combined coagulating and disinfecting effect of the salt containing copper was less efficient in removing the bacteria than was the case when the same salt without copper was used, although the removal of B. coli was somewhat better, the reduction in bacteria varying between 54 and 95 per cent. for the salt containing copper and between 70 and 98 per cent. for the straight iron salt, while the reduction of B. coli by the copper salt was 97 to 99 per cent. and by the iron salt was at all times below 97 per cent., and during one run averaged less than 19 per cent.

During all the periods when lime was used it was added in sufficient quantity to make the effluent of the filter alkaline to phenolphthalein in order to ensure the complete removal of all added iron and copper.

The experiments, while largely preliminary in character, indicate clearly that the satisfactory removal of color, turbidity and a considerable portion of the organic matter as represented by the albuminoid ammonia, may be accomplished by coagulation with sulphate of alumina, or with one of the three forms of ferrous sulphate mentioned combined with lime, with subsequent filtration at rates of 25,000,000 gallons per day or somewhat higher in filters of the mechanical type. The removal of 90 to 99 per cent. of the bacteria occurs only when the removal of suspended matter is practically complete.

The numbers of bacteria in the filtered water were never less than 1,000 per cubic centimeter and rarely less than 10,000 per cubic centimeter during any portion of the experiments, while the numbers of B. coli were at all times as large or larger than in the very polluted Merrimack River water.

The cost of coagulants necessary to produce an effluent free from suspended matter was so large as to render the process apparently impracticable. The results obtained during the early portion of the experiments indicated, however, that clarification might be produced at less cost with sulphate of alumina than with either of the iron salts tested, for the reason that much larger amounts of the cheaper iron salts must be used, and that they also require the addition of lime.

In the following tables are shown the various data regarding the operation and work of the filter, the results being grouped according to the rate of filtration and the kind and amount of coagulants used: —

| Number of Run. | Period of Operation. | Time between Washings (Hours). | Million Gallons per Acre. | | Chemicals Applied (Grains per Gallon). | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Per 24 Hours. | Between Washings. | Sulphate of Alumina. | Copperas. | Copper Iron Sulphate. | Lime. |
| | 1906. | | | | | | | |
| 1 to 3, inclusive, | April 20 to 23, | 6.3 | 48.9 | 12.80 | 1.3 | - | - | - |
| 4 to 6, inclusive, | April 24 to 30, | 7.7 | 59.9 | 23.17 | 2.0 | - | - | - |
| 7, 8 and 12 to 19, | May 1, 2, 4 to 11, | 5.2 | 49.9 | 10.72 | 2.6 | - | - | - |
| 9 to 11, | May 2 to 4, | 4.1 | 51.7 | 8.88 | 3.5 | - | - | - |
| 20 to 21, | May 16 to 21, | 14.1 | 49.1 | 29.12 | - | 3.1 | - | 0.0 |
| 22 to 25, | May 22 to 29, | 9.5 | 50.8 | 20.02 | - | 4.7 | - | 0.0 |
| 26 to 30, | May 29 to June 15, | 11.3 | 48.6 | 22.92 | - | 8.7 | - | 0.0 |
| 31 to 46, | June 19 to 29, | 3.9 | 48.7 | 7.96 | - | 9.4 | - | 2.1 |
| 47 to 51, | July 2 to 13, | 5.7 | 51.0 | 12.06 | - | 8.2 | - | 2.4 |
| 52 to 60, | July 16 to 27, | 5.8 | 51.7 | 12.55 | - | 8.5 | - | 3.4 |
| 61 to 63, | July 30, August 1, | 4.7 | 53.0 | 10.30 | - | 8.5 | - | 3.8 |
| 64 to 68, | Aug. 3 to 9, | 5.9 | 53.3 | 12.96 | - | 7.9 | - | 4.2 |
| 69 to 72, | Aug. 10 to 17, | 5.5 | 53.0 | 12.04 | - | 8.5 | - | 5.4 |
| 73 to 75, | Aug. 21 to 24, | 10.0 | 26.5 | 11.06 | - | 8.5 | - | 6.0 |
| 76, | Aug. 27, | 8.2 | 27.0 | 9.12 | - | 7.3 [1] | - | 5.5 |
| 77 to 79, | Aug. 28 to Sept. 7, | 19.3 | 26.8 | 21.57 | - | 8.3 [1] | - | 8.8 |
| 82 to 84, | Sept. 17 to 21, | 11.5 | 27.0 | 12.93 | - | 8.0 [1] | - | 9.3 |
| 87, 88, 90, 91 and 94, | Oct. 1 to 4, 23 to 26, 29 to 31, | 17.0 | 27.0 | 18.99 | - | 8.0 [1] | - | 8.9 |
| 80 and 81, | Sept. 10 to 14, | 16.4 | 27.0 | 18.64 | - | - | 9.7 | 12.7 |
| 85 and 86, | Sept. 24 to 28, | 19.1 | 26.5 | 21.08 | - | - | 7.9 | 9.5 |
| 89, 92 and 93, | Oct. 10 to 12, Nov. 1 to 21, | 15.8 | 26.5 | 17.39 | - | - | 8.0 | 8.9 |

[1] Sugar sulphate of iron.

## *Settled Trickling Filter Effluents applied to Filter No. 300.*

[Parts per 100,000.]

| Number of Run. | Appearance. | | | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Iron. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Albuminoid. | | | | | | | |
| | Turbidity. | Sediment. | Color. | Free. | Total. | In Suspension. | | Nitrates. | Nitrites. | | | |
| 1 to 3, inclusive, | 2.5 | 0.0 | .59 | 1.79 | .18 | .03 | 9.80 | 1.49 | .3000 | 0.87 | - | 8.7 |
| 4 to 6, inclusive, | 1.9 | 0.0 | .60 | 1.83 | .22 | .07 | 10.50 | 0.92 | .0875 | 1.21 | - | 11.7 |
| 9 to 11, inclusive, | - | - | .62 | 1.15 | .21 | .09 | 12.50 | 1.64 | .1200 | 1.56 | - | 9.4 |
| 7 and 8 and 12 to 19, inclusive, | 3.1 | 0.1 | .69 | 2.64 | .25 | .08 | 13.11 | 0.80 | .0762 | 1.22 | - | 16.0 |
| 20 to 30, inclusive, | 2.9 | -[1] | .85 | 2.28 | .22 | .08 | 14.71 | 1.62 | .0632 | 1.30 | .3243 | 11.1 |
| 31 to 46, inclusive, | 1.3 | 0.4 | .56 | 1.58 | .16 | .05 | 13.39 | 1.62 | .0679 | 0.96 | .2129 | 9.0 |
| 47 to 51, inclusive, | 4.0 | 0.1 | .54 | 1.97 | .11 | .02 | 16.20 | 1.63 | .0565 | 0.85 | .1775 | 11.9 |
| 52 to 60, inclusive, | 2.1 | -[1] | .50 | 1.81 | .11 | .02 | 14.28 | 1.80 | .0592 | 0.82 | .1345 | 9.0 |
| 61 to 63, inclusive, | 1.8 | -[1] | .48 | 1.38 | .08 | .01 | 18.20 | 1.64 | .0400 | 0.88 | .1620 | 9.4 |
| 64 to 68, inclusive, | 0.9 | 0.0 | .46 | 1.14 | .08 | .01 | 14.84 | 1.83 | .0410 | 0.69 | .1032 | 2.7 |
| 69 to 72, inclusive, | 1.3 | 0.0 | .46 | 1.17 | .08 | .01 | 15.28 | 1.68 | .0168 | 0.88 | .1093 | 2.5 |
| 73 to 75, inclusive, | 1.0 | 0.0 | .48 | 1.24 | .08 | .01 | 20.20 | 1.56 | .0225 | 0.87 | .0930 | 2.8 |
| 77 to 79, inclusive, | 1.9 | 0.0 | .59 | 1.95 | .11 | .02 | 20.20 | 1.23 | .0287 | 1.06 | .1765 | 3.0 |
| 82 to 84, inclusive, | 1.9 | -[1] | .57 | 1.98 | .13 | .03 | 18.40 | 1.04 | .0610 | 1.18 | .2736 | 2.7 |
| 87, 88, 90, 91 and 94, | 2.9 | 0.0 | .77 | 3.04 | .28 | .07 | 14.62 | 0.49 | .0708 | 1.72 | .4114 | 3.3 |
| 80 and 81, | 2.3 | 0.0 | .60 | 1.98 | .13 | .02 | 13.95 | 1.00 | .0513 | 1.11 | .3000 | 3.1 |
| 85 and 86, | 2.2 | 0.0 | .66 | 2.36 | .15 | .03 | 17.18 | 1.34 | .0280 | 1.31 | .3456 | 2.7 |
| 89, 92 and 93, | 3.3 | 0.0 | .78 | 3.38 | .30 | .08 | 14.10 | 0.31 | .0587 | 1.86 | .4160 | 3.7 |

[1] Less than 0.1.

## *Effluent of Filter No. 300.*

[Parts per 100,000.]

| Number of Run. | Appearance. | | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Iron. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity. | Sediment. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | | |
| 1 to 3, inclusive, | 1.5 | –[1] | 0.55 | 2.05 | .16 | 9.95 | 1.05 | .3400 | 1.11 | – | 10,7 |
| 4 to 6, inclusive, | 0.9 | 0.0 | 0.48 | 1.59 | .14 | 9.80 | 0.76 | .1200 | 0.86 | – | 10.9 |
| 9 to 11, inclusive, | 0.0 | 0.0 | 0.12 | 1.40 | .08 | 11.30 | 0.77 | .0800 | 0.65 | – | 7.9 |
| 7 and 8 and 12 to 19, inclusive, | 0.1 | 0.0 | 0.29 | 2.00 | .11 | 11.26 | 0.83 | .0486 | 0.57 | – | 9.1 |
| 20 to 30, inclusive, | 3.4 | 0.0 | 1.64 | 2.15 | .16 | 14.05 | 1.31 | .0862 | 0.86 | 1.7200 | 9.5 |
| 31 to 46, inclusive, | 0.1 | 0.0 | 0.58 | 1.49 | .06 | 12.00 | 1.07 | .0609 | 0.39 | 0.5320 | 9.3 |
| 47 to 51, inclusive, | 0.1 | 0.0 | 0.60 | 1.94 | .06 | 13.95 | 0.87 | .0380 | 0.47 | 0.5225 | 13.3 |
| 52 to 60, inclusive, | 0.1 | 0.0 | 0.31 | 1.51 | .05 | 12.48 | 1.20 | .0583 | 0.31 | 0.0780 | 12.4 |
| 61 to 63, inclusive, | –[1] | 0.0 | 0.45 | 1.60 | .04 | 15.90 | 1.10 | .0600 | 0.30 | 0.3620 | 11.8 |
| 64 to 68, inclusive, | 0.0 | 0.0 | 0.18 | 1.35 | .05 | 13.34 | 1.06 | .0850 | 0.27 | 0.0628 | 0.2 |
| 69 to 72, inclusive, | 0.0 | 0.0 | 0.19 | 1.27 | .04 | 13.18 | 1.18 | .0550 | 0.30 | 0.0167 | 0.8 |
| 73 to 75, inclusive, | 0.0 | 0.0 | 0.18 | 1.70 | .04 | 14.35 | 0.72 | .0713 | 0.29 | 0.0143 | 0.5 |
| 77 to 79, inclusive, | 0.0 | 0.0 | 0.21 | 1.59 | .05 | 15.70 | 0.43 | .0563 | 0.43 | 0.0217 | 0.9 |
| 82 to 84, inclusive, | 0.0 | 0.0 | 0.25 | 1.84 | .06 | 14.60 | 0.45 | .0900 | 0.43 | 0.0176 | 2.3 |
| 87, 88, 90, 91 and 94, | 0.0 | 0.0 | 0.27 | 2.64 | .09 | 11.60 | 0.05 | .0344 | 0.61 | 0.0374 | 3.4 |
| 80 and 81, | 0.0 | 0.0 | 0.17 | 1.38 | .04 | 10.78 | 0.56 | .0525 | 0.30 | 0.0175 | 2.1 |
| 85 and 86, | 0.1 | 0.0 | 0.25 | 1.96 | .06 | 13.50 | 0.51 | .0720 | 0.52 | 0.0284 | 3.3 |
| 89, 92 and 93, | 0.2 | 0.0 | 0.33 | 2.76 | .10 | 10.90 | 0.01 | .0102 | 0.67 | 0.0690 | 3.5 |

[1] Less than 0.1.

## *Percentage Reduction of Turbidity, Color and Albuminoid Ammonia.*

*Filter No. 300.*

| Number of Run. | Turbidity. | Color. | Total Albuminoid Ammonia. |
|---|---|---|---|
| 1 to 3, inclusive, | 40.0 | 6.8 | 10.0 |
| 4 to 6, inclusive, | 52.7 | 29.0 | 36.0 |
| 9 to 11, inclusive, | – | 80.6 | 61.6 |
| 7 and 8 and 12 to 19, inclusive, | 96.8 | 58.0 | 57.0 |
| 20 to 30, inclusive, | 0.0 | 0.0 | 28.5 |
| 31 to 46, inclusive, | 92.3 | 0.0 | 61.9 |
| 47 to 51, inclusive, | 97.5 | 0.0 | 45.8 |
| 52 to 60, inclusive, | 95.2 | 38.0 | 54.1 |
| 61 to 63, inclusive, | 94.5 | 0.0 | 51.2 |
| 64 to 68, inclusive, | 100.0 | 60.9 | 40.2 |
| 69 to 72, inclusive, | 100.0 | 58.7 | 48.1 |
| 73 to 75, inclusive, | 100.0 | 62.5 | 50.3 |
| 77 to 79, inclusive, | 100.0 | 64.4 | 56.7 |
| 82 to 84, inclusive, | 100.0 | 56.2 | 54.3 |
| 87, 88, 90, 91 and 94, | 100.0 | 65.0 | 66.7 |
| 80 and 81, | 100.0 | 71.7 | 70.1 |
| 85 and 86, inclusive, | 95.5 | 62.2 | 59.8 |
| 89, 92 and 93, | 98.9 | 57.7 | 66.4 |

| Number of Run. | Average Bacteria per Cubic Centimeter. | | | Average B. Coli per Cubic Centimeter. | | |
|---|---|---|---|---|---|---|
| | Raw Water. | Effluent from Coagulation Basin. | Effluent from Filter. | Raw Water. | Effluent from Coagulation Basin. | Effluent from Filter. |
| 1 to 3, inclusive, | 373,300 | 743,300 | 353,300 | 4,470 | 2,400 | 1,300 |
| 4 to 6, inclusive, | 434,000 | 586,300 | 683,000 | 2,600 | 2,500 | 1,700 |
| 9 to 11, inclusive, | 1,310,000 | 1,930,000 | 325,000 | 4,700 | 2,050 | 175 |
| 7 and 8 and 12 to 19, inclusive, | 1,417,500 | 2,560,000 | 1,466,600 | 14,000 | 2,400 | 1,900 |
| 20 to 30, inclusive, | 1,393,800 | 1,079,600 | 931,300 | 114,700 | 15,100 | 137,000 |
| 31 to 46, inclusive, | 177,300 | 271,000 | 33,400 | 41,300 | 60,400 | 6,100 |
| 47 to 51, inclusive, | 506,700 | 243,300 | 33,000 | 187,500 | 3,800 | 2,800 |
| 52 to 60, inclusive, | 119,500 | 140,000 | 19,800 | 9,500 | 3,000 | 735 |
| 61 to 63, inclusive, | 315,000 | 18,500 | 14,300 | 40,000 | 2,000 | 565 |
| 64 to 68, inclusive, | 134,000 | 21,200 | 2,700 | 6,800 | 750 | 115 |
| 69 to 72, inclusive, | 311,300 | 13,500 | 4,100 | 9,300 | 170 | 310 |
| 73 to 75, inclusive, | 279,000 | 22,900 | 5,400 | 14,400 | 245 | 55 |
| 76, | 1,100,000 | 18,000 | 4,000 | 4,800 | 3,900 | 120 |
| 77 to 79, inclusive, | 455,000 | 33,100 | 3,800 | 30,000 | 625 | 205 |
| 82 to 84, inclusive, | 576,000 | 55,400 | 4,200 | 14,800 | 900 | 83 |
| 87, 88, 90, 91 and 94, | 606,400 | 180,200 | 62,700 | 54,800 | 3,800 | 900 |
| 80 and 81, | 387,500 | 19,700 | 6,000 | 25,100 | 185 | 100 |
| 85 and 86, | 269,000 | 51,800 | 3,400 | 11,400 | 270 | 86 |
| 89, 92 and 93, | 643,000 | 296,400 | 203,900 | 100,800 | 3,000 | 1,400 |

| Number of Run. | Per Cent. of Bacteria removed by | | | Per Cent. of B. Coli removed by | | |
|---|---|---|---|---|---|---|
| | Coagulation. | Filter. | System. | Coagulation. | Filter. | System. |
| 1 to 3, inclusive, | 0.0 | 5.5 | 52.5 | 46.2 | 70.9 | 45.8 |
| 4 to 6, inclusive, | 0.0 | 0.0 | 0.0 | 3.8 | 34.5 | 32.0 |
| 9 to 11, inclusive, | 0.0 | 75.2 | 83.2 | 56.3 | 98.3 | 91.5 |
| 7 and 8 and 12 to 19, inclusive, | 0.0 | 0.0 | 42.6 | 82.9 | 86.5 | 20.8 |
| 20 to 30, inclusive, | 22.3 | 33.2 | 13.8 | 86.9 | 0.0 | 0.0 |
| 31 to 46, inclusive, | 0.0 | 81.2 | 87.7 | 0.0 | 85.2 | 89.9 |
| 47 to 51, inclusive, | 52.0 | 93.5 | 86.4 | 98.0 | 98.5 | 25.7 |
| 52 to 60, inclusive, | 0.0 | 83.4 | 85.9 | 68.4 | 92.2 | 75.4 |
| 61 to 63, inclusive, | 41.3 | 95.5 | 22.6 | 95.0 | 85.8 | 71.7 |
| 64 to 68, inclusive, | 84.2 | 98.0 | 87.3 | 89.0 | 93.3 | 84.7 |
| 69 to 72, inclusive, | 95.7 | 98.7 | 69.6 | 98.2 | 96.6 | 0.0 |
| 73 to 75, inclusive, | 91.8 | 76.4 | 98.1 | 98.3 | 77.6 | 99.6 |
| 76, | 98.3 | 77.8 | 99.6 | 18.6 | 96.9 | 97.5 |
| 77 to 79, inclusive, | 92.7 | 98.9 | 99.2 | 97.9 | 67.2 | 99.3 |
| 82 to 84, inclusive, | 90.4 | 92.4 | 99.3 | 93.9 | 90.8 | 99.4 |
| 87, 88 and 90, 91 and 94, | 70.3 | 65.2 | 89.7 | 93.1 | 76.4 | 98.4 |
| 80 and 81, | 94.9 | 69.6 | 98.5 | 99.3 | 46.0 | 99.6 |
| 85 and 86, | 80.8 | 93.4 | 96.7 | 97.6 | 68.2 | 99.2 |
| 89, 92 and 93, | 54.0 | 31.0 | 68.3 | 97.0 | 53.3 | 98.6 |

*Cost of Chemicals per Million Gallons filtered.*

*Filter No. 300.*

| Number of Run. | Sulphate of Alumina. | Copperas. | Copper Iron Sulphate. | Lime. | Total. |
|---|---|---|---|---|---|
| 1 to 3, inclusive, | $1 86 | - | - | - | $1 86 |
| 4 to 6, inclusive, | 2 86 | - | - | - | 2 86 |
| 7, 8, 12 to 19, inclusive, | 3 72 | - | - | - | 3 72 |
| 9 to 11, inclusive, | 5 00 | - | - | - | 5 00 |
| 20 to 21, inclusive, | - | $2 25 | - | - | 2 25 |
| 22 to 25, inclusive, | - | 3 41 | - | - | 3 41 |
| 26 to 30, inclusive, | - | 6 30 | - | - | 6 30 |
| 31 to 46, inclusive, | - | 6 82 | - | $0 90 | 7 72 |
| 47 to 51, inclusive, | - | 5 94 | - | 1 03 | 6 97 |
| 52 to 60, inclusive, | - | 6 16 | - | 1 46 | 7 62 |
| 61 to 63, inclusive, | - | 6 16 | - | 1 63 | 7 79 |
| 64 to 68, inclusive, | - | 5 73 | - | 1 82 | 7 55 |
| 69 to 72, inclusive, | - | 6 16 | - | 2 32 | 8 48 |
| 73 to 75, inclusive, | - | 6 54 | - | 2 58 | 9 12 |
| 76, | - | 5 40 [1] | - | 2 37 | 7 77 |
| 77 to 79, inclusive, | - | 6 10 [1] | - | 3 78 | 9 88 |
| 82 to 84, inclusive, | - | 5 80 [1] | - | 4 00 | 9 80 |
| 87, 88, 90, 91 and 94, | - | 5 80 [1] | - | 3 83 | 9 63 |
| 80 and 81, | - | - | $7 55 | 5 46 | 13 01 |
| 85 and 86, | - | - | 6 15 | 4 08 | 10 23 |
| 89, 92 and 93, | - | - | 6 22 | 3 83 | 10 05 |

[1] Sugar sulphate of iron.

## Purification of Industrial Wastes.

During 1906, as during many other years, special investigations were carried on upon methods for the purification of wastes from various manufacturing industries. The results of these investigations are presented in the following pages.

### *A Carpet Company's Works.*

The wastes were principally from scouring and washing wool and yarn, and from dyeing. They were heavy, soapy liquids, semi-emulsions of fat, dirt and soap, and contained seventy to one hundred times as much solid matter as an ordinary Massachusetts sewage. The volume produced each day varied from 75,000 to 100,000 gallons.

The following table shows the amount of waste from the various machines at the mills: —

| Source of Waste. | Gallons per Day. | Source of Waste. | Gallons per Day. |
|---|---|---|---|
| Strip washer, | 3,850 | Yarn washer No. 2, | 1,047 |
| Drum sheet tank, | 358 | Centrifugal washer, | 3,000 |
| Sheet washer tank, | 270 | Wool-dyeing machine, | 2,950 |
| Sheet washer (continuous flow), | 14,600 | Brussels yarn dye tubs, blue and black. | 1,140 |
| Hot washer and paste barrels, | 150 | Washing tank (continuous flow), | 3,270 |
| Wool-scouring machine, | 1,700 | Blue dye washing machine, | 18,730 |
| Brussels dye tubs, | 7,460 | Yarn dyers (three), | 15,550 |
| Yarn rinse box, | 10,500 | Wool-dyer machine (rinsing), | 2,950 |
| Yarn washer No. 1, | 1,047 | | |

The waste dye liquors were densely colored, green and red hues predominating, and generally acid. Mixtures of the various wastes in proportion to the amount of each gave a liquor exceedingly rich in organic matter and of a green color, but this mixed liquor was alkaline, owing to the large volume of wool-scouring liquor present, and this was the waste upon which the experiments upon sedimentation, chemical precipitation and filtration were made. At times samples of the waste liquors from all the drains of the works were collected and forwarded to the Lawrence Experiment Station, and at times the average waste from the works was forwarded; but when the different waste liquors were received, they were mixed, in order that an average waste might be used. It was found that allowing the mixed or average waste liquor to stand for twenty-four hours for sedimentation to occur removed about 50 per cent. of the total nitrogenous organic matter present, and about 60 per cent. of the total organic matter.

Ordinary coagulants, except in excessive and costly amounts, had comparatively little effect on the organic matter remaining after sedimentation. Copperas and lime, when applied at the rate of 2,500 pounds of each per million gallons of liquor, reduced the nitrogenous matter remaining in the supernatant liquid after sedimentation about 23 per cent., and the total organic matter 35 per cent. The same precipitants when used at the rate of 5,000 pounds per million gallons reduced the nitrogenous matter 34.5 per cent., and the total organic matter remaining 50 per cent.

During 1905, seven filters, constructed of different filtering materials, were started and kept in operation for five weeks, for the purpose of studying the most suitable and efficient method for the filtration of these

wastes. Three of these were tube filters constructed of sand of an effective size of 0.33 millimeter, and were operated at rates varying from 100,000 to 500,000 gallons per acre daily. The other four filters were constructed of cinders, soft coal, coke breeze and charcoal, and each was operated at the rate of 500,000 gallons, with the exception of the cinder filter, which was operated at a rate of 1,000,000 gallons per acre daily. To these filters was applied the supernatant liquor after twenty-four hours' sedimentation of the waste. The results of these experiments showed that a sand filter at a comparatively low rate gave the best purification; that by chemical precipitation followed by sand filtration at a higher rate than that of the filter receiving the supernatant liquor from simple sedimentation more organic matter could be removed, but not enough to compensate for the chemicals used; that with a cinder filter operated at a 1,000,000-gallon rate nearly as good purification could be obtained as with the low-rate sand filter, but excessive clogging necessitated frequent removal of filtering material; that a coke breeze filter at a 500,000-gallon rate gave as good results as a cinder filter at a 1,000,000-gallon rate, and nearly as good results as the low-rate sand filter; and that none of the filters removed much of the green color of the applied liquor.

In December, 1905, additional experiments were begun at the experiment station with wastes collected at the works. Like the previous samples shipped to the station, these wastes were green in color, very turbid and quickly putrefied. Six filters were put into operation, receiving the supernatant liquor after sedimentation of the entire waste, one being constructed of cinders and the others of sand, and these filters were continued in operation for nearly seven months. A filter constructed of 18 inches in depth of cinders was operated at a rate of 500,000 gallons, and its effluent was applied to a filter constructed of 27 inches in depth of sand and operated at a rate of 100,000 gallons per acre daily. This combination of filters removed from the liquid applied to it 62 per cent. of the nitrogen determined as albuminoid ammonia, 62 per cent. of the organic nitrogen, 65 per cent. of the organic matter determined as oxygen consumed, 23 per cent. of the total solids, and 56 per cent. of the combustible solids.

A second combination, consisting of three sand filters of equal areas and each constructed of 3½ feet in depth of sand, was put into operation at the same time, the supernatant liquor after sedimentation being applied to the first of these sand filters at a rate of 100,000 gallons per acre daily, the effluent of the first filter to the second, and the effluent of the second to the third. As a result of this experiment the percentage removal of the organic matters, etc., in the applied liquors was as follows: —

*Per Cent. removed.*

| Filter No. | Ammonia. | | Kjeldahl Nitrogen. | Oxygen Consumed. | Solids. | | |
|---|---|---|---|---|---|---|---|
| | Free. | Albuminoid. | | | Total. | Loss. | Fixed. |
| 293, . . . . | 53 | 56 | 66 | 65 | 24 | 53 | 7 |
| 293 and 294, . . | 77 | 71 | 77 | 76 | 40 | 72 | 22 |
| 293, 294 and 295, . | 78 | 81 | 86 | 84 | 51 | 79 | 33 |

During the same period, a filter of the same depth of sand, Filter No. 296, was operated at one-third the rate of each of the three filters just described, namely, 33,300 gallons per acre daily, this rate giving the same rate per unit of surface as the combination just described. The percentage removal of matter present in the applied liquor was as follows, and was practically the same as by the three filters operated at higher rates: —

*Per Cent. removed.*

| Filter No. | Ammonia. | | Kjeldahl Nitrogen. | Oxygen Consumed. | Solids. | | |
|---|---|---|---|---|---|---|---|
| | Free. | Albuminoid. | | | Total. | Loss. | Fixed. |
| 296, . . . . | 76 | 78 | 84 | 82 | 46 | 72 | 30 |

The effluents of all these filters, with the exception of the shallow cinder filter, were clear and generally green in color. They were perfectly stable, no putrefaction ensuing when kept in the warm laboratory for weeks, although the waste quickly putrefied. The work done by all these filters improved steadily, nitrification taking place in each of them during the last two months of operation.

*Summary.* — The results from all the work carried on with these wastes during the period described proved that an effluent of good quality could be obtained by constructing settling tanks holding one day's flow from the mill, followed by sand filtration of the supernatant liquor at a rate as high as 50,000 gallons per acre daily, such sedimentation removing about 50 per cent. of the total organic matter present and filtration removing about 75 per cent. of that remaining.

Average analyses of average samples of waste liquor, supernatant liquor and filter effluents follow.

*Average Analysis of Average Samples of Untreated Waste Liquor.*

[Parts per 100,000.]

| Residue. | | Loss on Ignition. | | Ammonia. | | | Kjeldahl Nitrogen. | Chlorine. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Free. | Albuminoid. | | | | |
| Total. | Dissolved. | Total. | Dissolved. | | Total. | Dissolved. | | | |
| 425.6 | 331.0 | 230.1 | 141.8 | 1.66 | 2.52 | 0.85 | 4.87 | 5.06 | 49.37 |

*Average Analyses of Supernatant Liquor.*

*Filter No. 284. — Applied Waste Liquor.*

Supernatant after twenty-four hours' sedimentation.

[Parts per 100,000.]

| 1905–06. | Turbidity. | Color. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Kjeldahl Nitrogen. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | |
| December, | - | - | 0.2700 | 0.5100 | - | - | - | 6.30 | 1.3612 |
| January, | - | - | 0.9920 | 0.8500 | 3.30 | - | - | 18.28 | 2.3300 |
| February, | - | - | 0.1750 | 0.3050 | - | - | - | 7.00 | 0.8724 |
| March, | - | - | 0.4900 | 0.4100 | 5.50 | - | - | 8.75 | 0.8249 |
| April, | - | - | 0.2400 | 2.3600 | - | - | - | 29.60 | 4.3700 |
| May, | - | - | 0.8033 | 0.7867 | - | - | - | 11.53 | - |
| June, | - | - | 1.4000 | 0.7200 | - | - | - | 6.50 | - |

Average solids: total=200.7; loss=89.7; fixed=111.0.

*Filter No. 284. — Effluent.*

Started Dec. 15, 1905. Two-inch filter, containing 18 inches of cinders passing a 4-inch mesh and held back by a 6-inch mesh. Rate, 500,000 gallons per acre daily. January 26, rate was decreased to 250,000 gallons per acre daily.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| December, | 1.0 | Green, | 0.2360 | 0.2263 | - | .00 | - | 2.44 | 0.4756 |
| January, | 1.0 | " | 0.8507 | 0.5753 | 4.74 | .00 | - | 11.95 | 1.6063 |
| February, | 2.0 | " | 0.4450 | 0.4607 | 1.20 | .02 | .0012 | 8.19 | 0.9211 |
| March, | 1.0 | " | 0.2912 | 0.3375 | 1.90 | .03 | - | 5.60 | 0.7167 |
| April, | 2.0 | " | 0.2700 | 0.8800 | - | .01 | - | 13.60 | 1.8780 |
| May, | - | - | 0.5100 | 0.4633 | - | .21 | - | 7.67 | - |
| June, | - | - | 0.5650 | 0.4090 | - | .11 | - | 8.25 | - |

Average solids: total=147.1; loss=42.9; fixed=104.2.

## *Average Analyses.*

### *Filter No. 285. — Effluent.*

**Three-inch filter, containing 27 inches in depth of sand of an effective size of 0.28 millimeter. Started Dec. 15, 1905. Operated at a rate of 100,000 gallons per acre daily, receiving the effluent of Filter No. 284.**

[Parts per 100,000.]

| 1905-06. | Turbidity. | Color. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Kjeldahl Nitrogen. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | |
| December, . | 0 | Green, | 0.2547 | 0.1120 | - | .13 | - | 1.68 | - |
| January, . . | 0 | " | 0.5980 | 0.3041 | 4.92 | .03 | - | 6.92 | 1.2710 |
| February, . | 1.0 | " | 0.3080 | 0.3030 | 1.00 | .06 | .0100 | 4.39 | 0.5912 |
| March, . . | 0 | " | 0.1380 | 0.1622 | 2.20 | .08 | - | 2.76 | 0.2808 |
| April, . . | 0 | " | 0.0450 | 0.2200 | - | .01 | - | 3.20 | 0.4378 |
| May, . . | - | - | 0.1100 | 0.2050 | - | .36 | - | 3.15 | - |
| June, . . | - | - | 0.0680 | 0.2245 | - | .52 | - | 3.38 | - |

**Average solids: total = 129.9; loss = 18.2; fixed = 111.7.**

### *Filter No. 293. — Effluent.*

**Three-inch filter, containing 3 feet in depth of sand of an effective size of 0.28 millimeter. Started Jan. 29, 1906. Operated at a rate of 100,000 gallons per acre daily with supernatant liquor after twenty-four hours' sedimentation.**

[Parts per 100,000.]

| 1906. | Turbidity. | Color. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Kjeldahl Nitrogen. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | |
| February, . | 3.0 | Green, | 0.0600 | 0.2983 | 2.80 | .01 | .0000 | 5.21 | 0.5249 |
| March, . . | 1.0 | " | 0.1940 | 0.2030 | 2.40 | .01 | - | 3.06 | 0.3386 |
| April, . . | 1.0 | " | 0.5600 | 0.1560 | - | .03 | - | 3.20 | 0.4378 |
| May, . . | - | - | 0.7783 | 0.2880 | - | .08 | - | 3.75 | - |
| June, . . | - | - | 1.0500 | 0.2820 | - | .13 | - | 3.88 | - |

**Average solids: total = 137.6; loss = 21.3; fixed = 116.3.**

### *Filter No. 294. — Effluent.*

**Duplicate in construction of Filter No. 293. Operated at a rate of 100,000 gallons per acre daily with the effluent of Filter No. 293.**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| February, . | 1.0 | Green, | 0.0689 | 0.1909 | 3.60 | .02 | .0010 | 3.22 | 0.3710 |
| March, . . | 0 | " | 0.0495 | 0.1260 | 2.40 | .01 | - | 2.19 | 0.2460 |
| April, . . | 0 | " | 0.2080 | 0.1280 | - | .03 | - | 1.70 | 0.2574 |
| May, . . | - | - | 0.0813 | 0.1613 | - | .57 | - | 1.93 | - |
| June, . . | - | - | 0.0480 | 0.1780 | - | .98 | - | 2.70 | - |

**Average solids: total = 118.3; loss = 12.4; fixed = 105.9.**

*Average Analyses* — Concluded.

*Filter No. 295. — Effluent.*

Duplicate in construction of Filter No. 293. Operated at a rate of 100,000 gallons per acre daily with the effluent of Filter No. 294.

[Parts per 100,000.]

| 1906. | Turbidity. | Color. | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Kjeldahl Nitrogen. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Free. | Albuminoid. | | Nitrates. | Nitrites. | | |
| February, | 0 | Green, | 0.1712 | 0.1088 | - | 0.08 | .0030 | 1.86 | 0.2019 |
| March, | 0 | " | 0.0355 | 0.0980 | 2.20 | 0.01 | - | 1.61 | 0.1459 |
| April, | 0 | " | 0.0240 | 0.0960 | - | 0.00 | - | 1.95 | 0.2082 |
| May, | - | - | 0.0707 | 0.1320 | - | 0.58 | - | 1.47 | - |
| June, | - | - | 0.0380 | 0.1280 | - | 1.29 | - | 1.95 | - |

Average solids: total = 101.2; loss = 10.4; fixed = 90.8.

*Filter No. 296. — Effluent.*

Duplicate in construction of Filter No. 293. Operated at a rate of 33,000 gallons per acre daily, receiving supernatant waste after sedimentation.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| January, | 0 | Green, | 0.4000 | 0.1800 | 3.10 | 0.12 | - | 3.90 | - |
| February, | 0.5 | " | 0.1122 | 0.1633 | - | 0.00 | .0100 | 2.36 | 0.2701 |
| March, | 0 | " | 0.0470 | 0.1020 | 1.10 | 0.01 | - | 1.61 | 0.1652 |
| April, | 0 | " | 0.0880 | 0.0920 | - | 0.08 | - | 1.45 | 0.1754 |
| May, | - | - | 0.0387 | 0.1240 | - | 0.55 | - | 1.78 | - |
| June, | - | - | 0.0280 | 0.1260 | - | 1.09 | - | 1.90 | - |

Average solids: total = 112.7; loss = 14.1; fixed = 98.6.

## *Wastes from Woolen Mill No. 1.*

The volume discharged from this mill was from 150,000 to 200,000 gallons in twenty-four hours. The average waste was non-putrescible, and contained considerable black dyestuff and suspended matter, which settled readily. This waste was applied to two filters, Nos. 301 and 303, each containing 3 feet in depth of sand of an effective size of 0.28 millimeter. Filter No. 301 was started July 27, 1906, and Filter No. 303 was started Aug. 10, 1906. They were operated part of the time at the rate of 100,000 gallons per acre daily and part of the time at a rate of 50,000 gallons per acre daily. The average rate of Filter No. 301 was 80,000 gallons per acre daily, and of Filter No. 303, 75,000 gallons per acre daily. Filter No. 301 received waste which had been treated with from 2,000 to 3,000 pounds each of lime and copperas per million gallons of waste. The waste so treated was clear and very nearly color-

less. Filter No. 303 received the settled untreated waste. The effluents from both filters were non-putrescible. The effluent of Filter No. 301 was clear and colorless, while that of Filter No. 303 was somewhat turbid and always contained considerable of the dyestuff. Except for the color, the effluent of Filter No. 303 was nearly as good, chemically, as that of Filter No. 301.

*Average Analyses of Waste Liquor, Filter Effluents and Percentage Removal of Organic Matter of Wastes from Woolen Mill No. 1.*

*Filter No. 301.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. Free. | Ammonia. Total Albuminoid. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| Raw, | 118.7 | 47.6 | .1200 | .8900 | - | - | 19.86 |
| Applied, | 166.4 | 13.1 | .0747 | .1340 | - | - | 2.90 |
| Effluent, | 121.8 | 8.7 | .0516 | .0950 | .07 | .0062 | 1.57 |
| Percentage removal: — | | | | | | | |
| By precipitation, | - | 72 | 38 | 85 | - | - | 85 |
| By precipitation and filtration, | - | 82 | 57 | 89 | - | - | 92 |
| By filtration, | 27 | 34 | 31 | 29 | - | - | 46 |

*Filter No. 303.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. Free. | Ammonia. Total Albuminoid. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| Raw, | 118.7 | 47.6 | .1200 | .8900 | - | - | 19.86 |
| Applied, | 123.9 | 28.5 | .1018 | .2960 | - | - | 11.90 |
| Effluent, | 105.3 | 10.4 | .0211 | .0751 | .00 | .0002 | 2.37 |
| Percentage removal: — | | | | | | | |
| By sedimentation, | - | 40 | 16 | 67 | - | - | 40 |
| By sedimentation and filtration, | 11 | 78 | 82 | 92 | - | - | 88 |
| By filtration, | 15 | 64 | 79 | 75 | - | - | 80 |

### *Wastes from Woolen Mill No. 2, and Treatment thereof.*

The waste discharged from this mill was from the processes of washing and dyeing cloth and dyeing raw stock. In cloth washing, the cloth was first saturated with soap in the fulling machines and then washed for a period of from twenty to thirty-five minutes. The total amount of wash water from this process was between 30,000 and 40,000 gallons per twenty-four hours, and from 12,000 to 15,000 gallons of this contained considerable soap; the remainder was practically clear. The dyes used were heavy logwood and aniline dyes, and the waste discharged consisted

of the spent dye liquor and rinse water used. The total volume of water from dyeing and rinsing amounted to about 21,000 gallons per day. The worst wastes discharged from the mill consisted of from 12,000 to 15,000 gallons of wash water used in washing cloth and about 12,000 gallons of spent dye liquor per twenty-four hours.

In October, 1906, a filter, No. 320, containing 3 feet in depth of sand of an effective size of 0.25 millimeter, was put into operation at the experiment station, receiving a mixture of these worst wastes, and this filter was operated at the rate of 100,000 gallons per acre daily. The waste as applied was very turbid, pinkish in color, non-putrescible, and deposited only a small amount of matter when allowed to stand. The effluent of the filter was clear, colorless and non-putrescible. This filter removed 77 per cent. of the organic matter in the applied waste, as shown by the loss-on-ignition determinations; 85 per cent., as shown by the albuminoid ammonia determinations; and 89 per cent., as shown by the determinations of oxygen consumed. Average analyses showing these results follow.

*Average Analyses of Waste Liquor, Filter Effluent and Percentage Removal of Organic Matter of Wastes from Woolen Mill No. 2.*

*Filter No. 320.*

| WASTE. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 162.3 | 62.4 | .1000 | .5830 | - | - | 11.40 |
| Applied, | 150.6 | 54.6 | .0700 | .3400 | - | - | 8.47 |
| Effluent, | 115.8 | 12.6 | .0280 | .0514 | .01 | .0023 | 0.97 |
| Percentage removal: — | | | | | | | |
| By sedimentation, | 7 | 12 | 30 | 42 | - | - | 23 |
| By sedimentation and filtration, | 29 | 80 | 72 | 91 | - | - | 91 |
| By filtration, | 23 | 77 | 60 | 85 | - | - | 89 |

*Wastes from a Shoddy Mill, and Treatment thereof.*

This mill manufactures goods from rags. From 60,000 to 70,000 gallons of waste liquor were discharged daily. Processes for carbonizing, washing and dyeing rags are carried on. The wastes discharged are from the process of washing the rags after carbonizing, and also the spent dye liquor from dyeing. Hematine dyes are used, and as the amount of dyeing at the mill during 1906 was comparatively small, the wastes from

this process were insignificant. The carbonizing process followed in the mill consists in treating the rags in a solution of sulphuric acid. The waste water and the wash water from washing the rags after carbonizing were dirty, and contained a considerable amount of sulphuric acid. From 250 to 1,200 pounds of lime were required per million gallons of waste to neutralize it, or about 20 to 100 pounds for the volume of waste discharged. The waste as received at the station contained considerable heavy black sediment, but the supernatant liquor was fairly clear, and the addition of lime caused still further clarification. The supernatant waste after neutralization was applied for two months to a sand filter, No. 302, containing 3 feet in depth of sand of an effective size of 0.28 millimeter, and this filter was operated at a rate of 100,000 gallons per acre daily. The effluent of this filter was clear, colorless, non-putrescible, and nitrification was active in it, as shown by the average analysis of the effluent given beyond.

The average analyses of the waste as received, as applied to the filter, and of the effluent of the filter are given below, and it will be seen that by sedimentation and filtration 75, 88 and 85 per cent. of the organic matter in the applied waste, as shown by loss-on-ignition, albuminoid ammonia and oxygen-consumed determinations, respectively, was removed.

*Average Analyses of Waste Liquor, Filter Effluent and Percentage Removal of Organic Matter of Wastes from a Shoddy Mill.*

*Filter No. 302.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 71.7 | 36.9 | .6400 | .4300 | - | - | 4.39 |
| Applied, | 53.6 | 10.1 | .6225 | .1298 | - | - | 1.94 |
| Effluent, | 61.1 | 9.4 | .0176 | .0534 | 1.01 | .0419 | 0.67 |
| Percentage removal: — | | | | | | | |
| By sedimentation, | 25 | 72 | 3 | 70 | - | - | 56 |
| By sedimentation and filtration, | 15 | 75 | 97 | 88 | - | - | 85 |
| By filtration, | - | 7 | 97 | 59 | - | - | 65 |

*Wastes from a Mill making Binders' Board, and Treatment thereof.*

During 1906, waste water from the process of making binders' board was discharged from this mill. This board was made from old paper and clay, and the waste was very dirty and contained much heavy suspended

matter. The volume discharged daily was from 250,000 to 300,000 gallons. The waste was generally light brown in color and the suspended matter present settled out readily. A filter, No. 310, containing 4 feet in depth of sand of an effective size of 0.25 millimeter, was put into operation Sept. 21, 1906, with the supernatant waste after sedimentation, and was operated at the rate of 200,000 gallons per acre daily. The waste as received putrefied quickly. The effluent of the filter, however, was fairly clear, practically odorless and non-putrescible. Average analyses of the waste as received, of the supernatant waste applied and of the effluent follow. These analyses show that the filter removed 50, 82 and 81 per cent. of the organic matter in the applied waste, as shown by the loss-on-ignition, albuminoid ammonia and oxygen-consumed determinations, respectively.

*Average Analyses of Waste Liquor, Filter Effluent and Percentage Removal of Wastes from a Mill making Binders' Board.*

*Filter No. 310.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 67.9 | 29.4 | .1800 | .3550 | - | - | 7.20 |
| Applied, | 32.1 | 16.0 | .1197 | .1980 | - | - | 3.72 |
| Effluent, | 24.9 | 7.9 | .0102 | .0355 | .11 | .0002 | 0.70 |
| Percentage removal:— | | | | | | | |
| By sedimentation, | 53 | 46 | 33 | 46 | - | - | 48 |
| By sedimentation and filtration, | 63 | 73 | 94 | 90 | - | - | 90 |
| By filtration, | 22 | 50 | 91 | 82 | - | - | 81 |

*Wastes from a Mill bleaching and washing Cloth, and Treatment thereof.*

The waste discharged by this mill was from the processes of boiling, bleaching and washing cloth. The various processes in detail are as follows: cloth is first boiled in a dilute solution of soda ash, and the waste from this process is a dark-brownish liquid containing considerable heavy suspended matter. After this, the cloth receives two separate washings, and this waste as discharged is clear and free from sediment. The second process is that of bleaching, the cloth being treated with a solution of chloride of lime. This solution is not wasted, but after bleaching, the cloth receives two separate washings, and this waste wash water is discharged. This waste water was fairly clear and free from

sediment. The third process consists of treating the cloth with weak sulphuric acid. This acid is not discharged until exhausted, but after this treatment the cloth is again washed, and this wash water is discharged into the river. The fourth and final process consists in boiling the cloth again in a solution of soda ash and soap. The waste water from this process is soapy and turbid. After this there are still three washings, and in each case the waste water is discharged. The total amount of waste discharged daily during 1906 was between 40,000 and 50,000 gallons, and there was also discharged once every two or three months a small volume of waste dye liquor.

A filter, No. 311, constructed of 3 feet in depth of sand of an effective size of 0.25 millimeter, was put into operation Sept. 26, 1906, receiving a mixture of the stronger of these wastes, at a rate of 50,000 gallons per acre daily. By the mixture of these strong wastes considerable soap was generally precipitated, and a fairly clear, supernatant liquor obtained. The effluent from the filter was clear, colorless and non-putrescible. The average analyses of the waste as received, of the waste applied to the filter and of the effluent of the filter follow. These analyses show that the filter removed 73, 89 and 91 per cent. of the organic matter in the applied waste, as shown by loss-on-ignition, albuminoid ammonia and oxygen-consumed determinations, respectively.

*Average Analyses of Waste Liquor, Filter Effluent and Percentage Removal of Organic Matter from a Mill bleaching and washing Cloth.*

*Filter No. 311.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 292.6 | 69.6 | .1887 | .6885 | - | - | 10.85 |
| Applied, | 249.4 | 54.8 | .1210 | .5660 | - | - | 8.85 |
| Effluent, | 182.1 | 14.8 | .0334 | .0614 | .04 | .0046 | 0.84 |
| Percentage removal:— | | | | | | | |
| By sedimentation, | 15 | 21 | 36 | 17 | - | - | 18 |
| By sedimentation and filtration, | 38 | 79 | 82 | 91 | - | - | 92 |
| By filtration, | 27 | 73 | 72 | 89 | - | - | 91 |

### *Wastes from a Mill dyeing, bleaching and mercerizing Cotton Yarn, and Treatment thereof.*

The wastes discharged from this mill come from the processes of dyeing, bleaching and mercerizing cotton yarn. The total amount of waste water discharged probably did not exceed 60,000 gallons per twenty-four hours at any time during the year. Of this total, about 25,000

gallons represent the worst of the wastes, namely, (1) water in which the yarn has been boiled with soda ash; (2) spent heavy dye liquor; (3) heavy rinse water from dyeing; (4) hot rinse water after mercerizing; (5) hot soap bath after bleaching; and (6) cold rinse after this soap bath. A composite waste, representing a combination of these six wastes in the right proportion, was used in the experiments.

On October 6, two filters were put into operation at the station, to which the average waste from this mill was applied. Each filter contained 3 feet in depth of sand of an effective size of 0.25 millimeter. To one of these filters, No. 318, the supernatant waste after sedimentation was applied at a rate of 50,000 gallons per acre daily. The average waste was brown in color, very turbid, and but a small portion of the matters in suspension settled readily. The effluent of this filter was, however, straw-colored, and had but slight odor. Average analyses given below show that this filter removed 56, 87 and 90 per cent. of the organic matter in the applied waste, as shown by loss-on-ignition, albuminoid ammonia and oxygen-consumed determinations, respectively.

The second filter, No. 319, received the supernatant waste after treatment with chemical precipitants, and its rate of operation was, also, 50,000 gallons per acre daily. Its effluent was only slightly better than that of Filter No. 318, as shown by the analyses given. This filter removed 69, 87 and 89 per cent. of the organic matter in the applied waste, as shown by loss-on-ignition, albuminoid ammonia and oxygen-consumed determinations, respectively, in the table of average analyses below.

*Average Analyses of Waste Liquor, Filter Effluents and Percentage Removal of Organic Matter from a Mill dyeing, bleaching and mercerizing Cotton Yarn.*

*Filter No. 318.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 453.2 | 101.7 | .1450 | 1.4900 | - | - | 32.30 |
| Applied, | 456.8 | 104.3 | .2050 | 1.5800 | - | - | 33.10 |
| Effluent, | 332.4 | 45.5 | .1016 | 0.2037 | .02 | .0198 | 3.45 |
| Percentage removal: — | | | | | | | |
| By filtration, | 27 | 56 | 50 | 87 | - | - | 90 |

*Average Analyses of Waste Liquor, etc.* — Concluded.

*Filter No. 319.*

| Waste. | Total Residue. | Total Loss on Ignition. | Ammonia. | | Nitrogen as | | Oxygen Consumed. |
|---|---|---|---|---|---|---|---|
| | | | Free. | Total Albuminoid. | Nitrates. | Nitrites. | |
| Raw, | 506.6 | 64.6 | .0900 | 0.9200 | - | - | 18.40 |
| Applied, | 503.6 | 49.4 | .1900 | 0.6200 | - | - | 11.60 |
| Effluent, | 365.1 | 15.5 | .0540 | 0.0807 | .07 | .0017 | 1.27 |
| Percentage removal:— | | | | | | | |
| By precipitation, | 1 | 24 | - | 33 | - | - | 37 |
| By precipitation and filtration, | 28 | 76 | 40 | 92 | - | - | 93 |
| By filtration, | 28 | 69 | 72 | 87 | - | - | 89 |

# WATER FILTRATION.

During 1906, studies upon the purification of water by sand filtration were continued, especial attention being paid to the operation of various combinations of filters for the purpose of studying double filtration, to the filtration of water of varying degrees of pollution and to the use of coagulants in connection with the filtration of polluted river water. The work of the Lawrence city filter was also followed.

## Lawrence City Filter and B. Coli Determinations.

The Lawrence city filter was constructed in 1893, and dividing walls separating it into three sections were built during 1902. The average depth of sand in the filter is about 4 feet, and the net filtering area, after deducting division walls, gate chambers and lateral carriers, is about 2.2 acres. As originally constructed, the filter contained sand of two different sizes, the portions of the filter immediately over the collecting underdrains being of finer sand than that in the remainder of the filter. Through the operations of scraping, washing and replacing sand, the two sizes of sand have become quite thoroughly mixed in the upper layers of the filter, and have at the present time an effective size of approximately 0.25 millimeter. Following tables present the average chemical and bacterial analyses of many samples of the Merrimack River water collected during the year as it flows upon the filter and of the filtered water collected at different points upon the supply system. During a considerable portion of the year, bacterial samples were collected daily, and samples for chemical analyses twice each month. Especial attention is called at this time to the determinations of B. coli in samples of the filtered city water, collected at different points upon the supply system. At the point farthest removed from the reservoir, namely, the experiment station, B. coli was found in 3.2 per cent. of the 1 cubic centimeter samples and in 50 per cent. of the 100 cubic centimeters samples examined. An examination of the tables will show that B. coli was found with hardly more frequency in 1 cubic centimeter samples collected directly from the filter than in the samples collected at the experiment station, although the water at the station must have been about two weeks on its journey from the filter. These results, together with many others given in this and preceding reports, both in connection with filtration investigations and special investigations such

as reported upon in the article upon copper sulphate in the report for 1905, show clearly the resistant, or hardy, property of certain B. coli that are capable of living and passing through sand filters. Taken in connection with the vital statistics of a city such as Lawrence, using polluted water, sand filtered, but having a low death rate and low typhoid rates, these accumulated B. coli results are of considerable value, as showing the relation between the B. coli efficiency of a filter and its real efficiency in disease prevention. It is evident, taking everything into consideration, that the determinations of B. coli in 100 cubic centimeters are of little value in connection with studies of the filtration of water of the character of that flowing in the Merrimack River at Lawrence. It is undoubtedly true, judging from the results of many years, that a sand filter treating such water, and showing B. coli present in not more than 10 per cent. of the 1 cubic centimeter samples of effluent examined, is producing an efficiently purified water from a bacterial point of view, assuming always that the positive B. coli results are not of samples collected consecutively or within a short period, but of samples scattered throughout a year. Further data showing the resistant character of B. coli are given in connection with Filter No. 218 (see page 310).

***Chemical Analyses.— Merrimack River.***

*Intake of the Lawrence City Filter.*

[Parts per 100,000.]

| Date. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Iron. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Albuminoid. | | | | | | | |
| | | Turbidity. | Color. | Free. | Total. | In Solution. | | Nitrates. | Nitrites. | | | |
| **1905.** | | | | | | | | | | | | |
| December, | 33 | 0.1 | .49 | .0108 | .0212 | .0177 | .34 | .029 | .0000 | .64 | .0345 | 1.3 |
| **1906.** | | | | | | | | | | | | |
| January, | 34 | 0.1 | .32 | .0099 | .0199 | .0148 | .30 | .019 | .0003 | .59 | .0350 | 0.9 |
| February, | 33 | 0.1 | .29 | .0114 | .0210 | .0168 | .33 | .018 | .0003 | .54 | .0305 | 1.1 |
| March, | 34 | 0.1 | .37 | .0063 | .0207 | .0166 | .31 | .013 | .0000 | .51 | .0320 | 1.0 |
| April, | 45 | 0.1 | .32 | .0037 | .0153 | .0136 | .15 | .017 | .0002 | .47 | .0457 | 0.8 |
| May, | 59 | 0.4 | .45 | .0047 | .0219 | .0172 | .11 | .011 | .0002 | .58 | .1505 | 0.8 |
| June, | 68 | 0.3 | .52 | .0082 | .0210 | .0186 | .15 | .009 | .0002 | .68 | .0496 | 1.0 |
| July, | 80 | 0.2 | .46 | .0115 | .0237 | .0200 | .27 | .011 | .0003 | .57 | .0565 | 1.3 |
| August, | 78 | 0.2 | .55 | .0164 | .0206 | .0165 | .42 | .006 | .0004 | .60 | .0725 | 1.4 |
| September, | 72 | 0.2 | .37 | .0190 | .0183 | .0147 | .51 | .012 | .0003 | .52 | .0700 | 1.6 |
| October, | 58 | 0.1 | .31 | .0208 | .0224 | .0186 | .56 | .014 | .0004 | .64 | .0670 | 1.3 |
| November, | 42 | 0.1 | .36 | .0136 | .0231 | .0204 | .48 | .016 | .0006 | .62 | .0630 | 1.2 |
| Average, | 53 | 0.2 | .40 | .0118 | .0207 | .0171 | .33 | .015 | .0003 | .58 | .0589 | 1.1 |

*Effluent of the Lawrence City Filter.*

[Parts per 100,000.]

| | Temperature (Deg. F.). | Appearance. | | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Iron. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Albuminoid. | | | | | | | |
| | | Turbidity. | Color. | Free. | Total. | In Solution. | | Nitrates. | Nitrites. | | | |
| Average, | 58 | 0.1— | .40 | .0105 | .0089 | .0086 | .35 | .034 | .0001 | .36 | .1072 | 1.4 |

*Water from the Outlet of the Distributing Reservoir.*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, | 58 | 0.1— | .36 | .0052 | .0095 | .0086 | .35 | .037 | .0001 | .35 | .0874 | 1.4 |

*Water from a Tap at Lawrence City Hall.*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, | 56 | 0.1— | .36 | .0037 | .0087 | - | .36 | .040 | .0001 | .33 | - | 1.3 |

*Water from a Tap at the Lawrence Experiment Station.*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, | 54 | 0.1— | .32 | .0022 | .0082 | - | .36 | .041 | .0000 | .32 | - | 1.4 |

*Merrimack River as it flows upon Lawrence City Filter.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Average Number of B. Coli per Cubic Centimeter. | Per Cent. of Samples containing B. Coli. |
|---|---|---|---|
| **1905.** | | | |
| December, | 11,500 | 122 | 100.0 |
| **1906.** | | | |
| January, | 8,600 | 105 | 100.0 |
| February, | 6,400 | 80 | 100.0 |
| March, | 5,400 | 57 | 100.0 |
| April, | 3,200 | 31 | 95.5 |
| May, | 1,600 | 51 | 100.0 |
| June, | 1,000 | 59 | 100.0 |
| July, | 6,200 | 143 | 80.0 |
| August, | 4,100 | 1,161 | 100.0 |
| September, | 2,600 | 61 | 100.0 |
| October, | 5,200 | 85 | 100.0 |
| November, | 1,900 | 44 | 100.0 |
| Average, | 4,800 | 167 | 98.0 |

*Effluent of Lawrence City Filter.*

[Average of Bacterial Analyses.]

| | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. | |
|---|---|---|---|---|
| | | | 1 c.c. | 100 c.c. |
| Average, . . . . . . . . . | 24 | 99.5 | 3.7 | 69.1 |

*Water from the Outlet of the Lawrence Reservoir.*

| | | | | |
|---|---|---|---|---|
| Average, . . . . . . . . . | 45 | - | 6.4 | 68.1 |

*Water from a Tap at Lawrence City Hall.*

| | | | | |
|---|---|---|---|---|
| Average, . . . . . . . . . | 46 | - | 4.4 | 44.3 |

*Lawrence City Water from a Tap at the Experiment Station.*

| | | | | |
|---|---|---|---|---|
| Average, . . . . . . . . . | 31 | - | 3.2 | 50.4 |

## Filter No. 8A.

This filter, 1/200 of an acre in area, was first put into operation during 1893. During the first four months of the year, the filter contained about 20 inches in depth of sand of an effective size of 0.23 millimeter, and was operated at a rate of about 5 million gallons per acre daily. During April, the sand above the underdrains in the filter was removed, 2 feet 6 inches of new sand of an effective size of 0.26 millimeter was placed in the filter, the old sand replaced above the new sand, and old and new sand at the point of junction thoroughly mixed. After refilling there was a total depth of 48 inches of sand in the filter. On May 17, the filter was again started filtering Merrimack River water at a rate of 5,000,000 gallons per acre daily. The filter was scraped thirteen times during the year. Owing to low water in the Essex Company's canal, the filter was not operated for periods of twenty-four hours or less on eight different days, and on two occasions the filter was out of operation for three and six days, respectively, on account of high water in the river.

### *Canal Water (Merrimack River Water).*

[Parts per 100,000.]

| Date. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Color. | Free. | Albuminoid. Total. | Albuminoid. In Solution. | | Nitrates. | Nitrites. | | | |
| **1905.** | | | | | | | | | | | | |
| December, . . | 37 | 0.2 | .48 | .0091 | .0155 | .0144 | .33 | .014 | .0000 | .72 | 101.0 | 0.8 |
| **1906.** | | | | | | | | | | | | |
| January, . . | 40 | 0.1— | .37 | .0084 | .0157 | .0143 | .29 | .020 | .0002 | .56 | 71.6 | 0.8 |
| February, . . | 41 | 0.1 | .30 | .0096 | .0180 | .0146 | .40 | .016 | .0002 | .54 | 96.6 | 1.1 |
| March, . . . | 35 | 0.1 | .37 | .0062 | .0155 | .0137 | .34 | .011 | .0001 | .55 | 83.8 | 1.0 |
| April, . . . | 46 | 0.1 | .36 | .0053 | .0139 | .0118 | .12 | .010 | .0001 | .39 | 64.5 | 1.0 |
| May, . . . | 60 | 0.1 | .41 | .0054 | .0150 | .0127 | .10 | .015 | .0005 | .50 | 69.0 | 0.9 |
| June, . . . | 65 | 0.3 | .60 | .0063 | .0198 | .0154 | .16 | .032 | .0002 | .63 | 29.8 | 0.9 |
| July, . . . | 73 | 0.3 | .51 | .0110 | .0196 | .0169 | .27 | .013 | .0004 | .54 | 36.9 | 1.2 |
| August, . . . | 75 | 0.2 | .49 | .0236 | .0192 | .0172 | .50 | .020 | .0004 | .52 | 40.0 | 1.4 |
| September, . . | 68 | 0.2 | .35 | .0339 | .0217 | .0180 | .60 | .014 | .0018 | .54 | 25.4 | 1.3 |
| October, . . . | 58 | 0.2 | .33 | .0328 | .0225 | .0200 | .60 | .017 | .0010 | .63 | 58.2 | 1.5 |
| November, . . | 42 | 0.1 | .37 | .0138 | .0202 | .0190 | .48 | .014 | .0006 | .65 | 74.5 | 1.2 |
| Average, . . | 53 | 0.2 | .41 | .0138 | .0181 | .0157 | .35 | .016 | .0005 | .56 | 62.6 | 1.1 |

### *Effluent of Filter No. 8A.*

[Parts per 100,000.]

| Date. | Quantity Applied. Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turbidity. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | | |
| **1905.** | | | | | | | | | | | | |
| December, . | 2,324,000 | 35 | 0.0 | .49 | .0026 | .0114 | .32 | .037 | .0000 | .61 | 64.2 | 0.8 |
| **1906.** | | | | | | | | | | | | |
| January, . . | 3,370,000 | 35 | 0.0 | .37 | .0031 | .0113 | .31 | .026 | .0000 | .49 | 73.7 | 0.9 |
| February, . | 3,263,000 | 36 | 0.0 | .28 | .0104 | .0102 | .40 | .029 | .0002 | .49 | 77.2 | 1.0 |
| March, . . | 3,492,000 | 35 | 0.0 | .29 | .0026 | .0105 | .35 | .019 | .0001 | .41 | 53.1 | 1.1 |
| April, . . | 3,035,000 | - | - | - | - | - | - | - | - | - | - | - |
| May, . . . | 4,674,000 | 62 | 0.0 | .02 | .0010 | .0046 | .05 | .012 | .0002 | .06 | 84.5 | 0.9 |
| June, . . | 4,497,000 | 67 | 0.0 | .29 | .0015 | .0104 | .17 | .024 | .0001 | .38 | 65.6 | 0.9 |
| July, . . | 4,710,000 | 74 | 0.0 | .30 | .0015 | .0106 | .33 | .023 | .0000 | .37 | 2.8 | 1.0 |
| August, . . | 4,686,000 | 77 | 0.0 | .31 | .0029 | .0110 | .50 | .024 | .0014 | .42 | 7.3 | 1.2 |
| September, . | 4,760,000 | 69 | 0.0 | .22 | .0047 | .0124 | .42 | .024 | .0025 | .45 | 2.7 | 1.4 |
| October, . . | 4,176,000 | 59 | 0.0 | .23 | .0011 | .0085 | .62 | .043 | .0000 | .39 | 36.2 | 1.3 |
| November, . | 4,375,000 | 42 | 0.0 | .28 | .0043 | .0143 | .51 | .027 | .0001 | .50 | 56.6 | 1.3 |
| Average, . | 3,946,800 | 54 | 0.0 | .28 | .0032 | .0105 | .36 | .026 | .0004 | .42 | 43.0 | 1.1 |

Filter run eight days in April; twelve days in May.

*Merrimack River Water (Essex Company's Canal).*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Average Number of B. Coli per Cubic Centimeter. | Per Cent. of Samples containing B. Coli. |
|---|---|---|---|
| 1905. | | | |
| December, | 6,300 | 97 | 96.0 |
| 1905. | | | |
| January, | 4,700 | 71 | 100.0 |
| February, | 4,200 | 65 | 100.0 |
| March, | 2,700 | 45 | 92.6 |
| April, | 2,400 | 21 | 100.0 |
| May, | 5,800 | 106 | 100.0 |
| June, | 7,200 | 96 | 100.0 |
| July, | 5,900 | 300 | 100.0 |
| August, | 5,600 | 820 | 100.0 |
| September, | 6,600 | - | - |
| October, | 7,600 | - | - |
| November, | 1,900 | - | - |
| Average, | 5,100 | 180 | 98.7 |

*Effluent of Filter No. 8A.*

[Average of Bacterial Analyses.]

| | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. | |
|---|---|---|---|---|
| | | | 1 c.c. | 100 c.c. |
| Average, | 110 | 98.7 | 25.1 | 78.4 |

## Filtration Experiments with Waters of Varying Degrees of Pollution.

### *Filters Nos. 218, 219 and 220.*

These three filters were started in July, 1903, for the purpose of studying the chemical and bacterial quality of effluents resulting from filtering waters of three different degrees of pollution.

Filters Nos. 218 and 219 are $\frac{1}{10000}$ of an acre in area and Filter No. 220 is $\frac{1}{5000}$ of an acre in area. In November, 1905, they contained 39 inches, 30 inches and 37 inches in depth of sand, respectively, of an effective size of 0.20 millimeter. During December, all of the filters were operated at a rate of 2,500,000 gallons, and from January 1 to November 30, at a rate of 5,000,000 gallons per acre daily.

Filter No. 218 has always received the Lawrence filtered water taken from the distribution main at the experiment station. The filter was scraped fourteen times during the year, ten of these scrapings being during the months of January, February and March, and were necessary on account of the removal of iron from the water applied. On February 2, the filtering material had become so badly clogged that it was impossible to relieve it by scraping, and the sand was washed in the tank in a manner similar to that employed for mechanical filters.

Filter No. 219 was operated during a large part of the year with Merrimack River water to which was added 2 per cent. by volume of strained sewage. From September 7 to September 23, inclusive, 4 per cent. of strained sewage was mixed with the applied water, and from September 24 until the end of the year, 6 per cent. of strained sewage was added. The filter was scraped twenty-eight times during the year, and was out of operation during the whole or part of seventeen different days on account of low water in the Essex Company's canal.

Filter No. 220 received Merrimack River water throughout the year, was scraped twenty-one times and was out of operation on account of low water during the whole or part of eighteen days.

*Chemical and Bacterial Results. — B. Coli.*

Filter No. 218, operating at an average rate of 4,747,000 gallons per acre daily, produced a water of an exceedingly satisfactory quality. The point of chief interest in the operation of this filter is that while it produced an effluent containing on an average but 9 bacteria per cubic centimeter, an effluent showing no B. coli when 1 cubic centimeter samples were examined yet contained enough B. coli to be detected in 32 per cent. of the 100 cubic centimeter samples examined, thus showing, as before mentioned in this report, the hardy resistant qualities of such B. coli as pass through the city filter. In this instance, the B. coli found in this effluent had not only passed through the city filter but had survived storage in the reservoir, passage through the supply mains and a second filtration. Filter No. 219 gave during eight months of the year a bacterial efficiency of approximately 99 per cent., but during these months B. coli were found in about 50 per cent. of 1 cubic centimeter samples examined, and after September 7, when the volume of sewage in the applied water was increased, not only did the bacterial efficiency of the filter diminish materially, but practically all 1 cubic centimeter samples examined contained B. coli. It was evident from all the results that the water applied throughout the year was too badly polluted to be rendered of a satisfactory quality by single sand filtration at the rate followed.

*Effluent of Filter No. 218.*

[Parts per 100,000.]

| | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turbidity. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | | |
| Average, . . | 4,747,400 | 57 | 0.0 | .23 | .0012 | .0075 | .34 | .068 | .0000 | .30 | 67.5 | 1.4 |

*Effluent of Filter No. 218.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. — 1 c.c. | 100 c.c. |
|---|---|---|---|---|
| **1905.** | | | | |
| December, | 4 | 93.3 | 0.0 | 8.3 |
| **1906.** | | | | |
| January, | 7 | 84.1 | 0.0 | 14.3 |
| February, | 9 | 59.1 | 0.0 | 33.3 |
| March, | 5 | 79.2 | 0.0 | 38.4 |
| April, | 11 | 62.1 | 0.0 | 41.6 |
| May, | 20 | 26.0 | 0.0 | 25.0 |
| June, | 10 | 72.2 | 0.0 | 45.4 |
| July, | 7 | 72.0 | 0.0 | 46.1 |
| August, | 15 | 57.2 | 0.0 | 35.7 |
| September, | 9 | 71.9 | - | - |
| October, | 4 | 92.1 | - | - |
| November, | 4 | 71.4 | - | - |
| Average, | 9 | 70.1 | 0.0 | 32.0 |

*Applied Water.—Filter No. 219.*

[Parts per 100,000.]

| | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turbidity. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | | |
| Average, . . | - | 56 | 0.7 | .42 | .0937 | .0298 | .63 | .023 | .0007 | .62 | 60.3 | 1.3 |

*Effluent of Filter No. 219.*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, . . | 4,565,000 | 57 | 0.0 | .33 | .0387 | .0126 | .52 | .031 | .0007 | .46 | 35.9 | 1.1 |

*Applied Water.— Filter No. 219.*

[Average of Bacterial Analyses.]

| | Average Number of Bacteria per Cubic Centimeter. | Average Number of B. Coli per Cubic Centimeter. | Per Cent. of Samples containing B. Coli. |
|---|---|---|---|
| **1905.** | | | |
| December, | 26,000 | 581 | 100.0 |
| **1906.** | | | |
| January, | 22,700 | 2,719 | 100.0 |
| February, | 21,200 | 810 | 100.0 |
| March, | 19,300 | 215 | 81.8 |
| April, | 15,000 | 360 | 92.4 |
| May, | 12,000 | 750 | 100.0 |
| June, | 11,500 | 1,075 | 90.0 |
| July, | 25,200 | 1,017 | 100.0 |
| August, | 8,400 | 452 | 100.0 |
| September, | 47,100 | 8,112 | 100.0 |
| October, | 61,200 | 7,600 | 100.0 |
| November, | 45,900 | 8,500 | 100.0 |
| Average, | 26,300 | 2,640 | 97.0 |

*Effluent of Filter No. 219.*

[Average of Bacterial Analyses.]

| | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. | |
|---|---|---|---|---|
| | | | 1 c.c. | 100 c.c. |
| **1905.** | | | | |
| December, | 135 | 99.5 | 38.4 | 76.9 |
| **1906.** | | | | |
| January, | 300 | 98.7 | 50.0 | 75.0 |
| February, | 190 | 99.1 | 33.3 | 100.0 |
| March, | 200 | 99.0 | 36.4 | 81.7 |
| April, | 80 | 99.5 | 53.8 | 100.0 |
| May, | 140 | 98.8 | 50.0 | 83.3 |
| June, | 130 | 98.9 | 50.0 | 57.2 |
| July, | 75 | 99.7 | 81.8 | 81.8 |
| August, | 270 | 96.8 | 50.0 | 78.6 |
| September, | 4,300 | 90.9 | 75.0 | 91.7 |
| October, | 6,900 | 88.7 | 100.0 | 100.0 |
| November, | 5,000 | 89.1 | 100.0 | 100.0 |
| Average, | 1,500 | 96.6 | 59.9 | 85.5 |

*Effluent of Filter No. 220.*[1]

[Parts per 100,000.]

| | Quantity Applied. Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, . . | 4,461,800 | 56 | 0.0 | .30 | .0034 | .0104 | .34 | .026 | .0002 | .43 | 51.3 | 1.1 |

[1] Canal water applied, see table, page 308.

*Effluent of Filter No. 220.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. 1 c.c. | Per Cent. of Samples containing B. Coli. 100 c.c. |
|---|---|---|---|---|
| **1905.** | | | | |
| December, . . . . . . . . . | 80 | 98.4 | 38.4 | 92.3 |
| **1906.** | | | | |
| January, . . . . . . . . . | 75 | 98.9 | 42.9 | 85.8 |
| February, . . . . . . . . . | 115 | 97.3 | 30.0 | 80.0 |
| March, . . . . . . . . . | 20 | 99.3 | 15.4 | 84.7 |
| April, . . . . . . . . . | 27 | 98.9 | 7.7 | 92.4 |
| May, . . . . . . . . . | 13 | 99.8 | 8.3 | 66.7 |
| June, . . . . . . . . . | 25 | 99.7 | 15.4 | 72.8 |
| July, . . . . . . . . . | 22 | 99.6 | 33.3 | 83.4 |
| August, . . . . . . . . . | 39 | 99.3 | 35.7 | 78.6 |
| September, . . . . . . . . . | 65 | 99.0 | - | - |
| October, . . . . . . . . . | 90 | 98.8 | - | - |
| November, . . . . . . . . . | 27 | 98.6 | - | - |
| Average, . . . . . . . . | 50 | 99.0 | 25.2 | 82.0 |

## Double Filtration.

Three filters, operated as secondary filters and receiving the effluents from other experimental water filters, were operated during the year. Two of them, Filters Nos. 244 and 286, were operated at a rate higher than that of the primary filter whose effluent they were receiving, while Filter No. 281 was operated at a rate lower than that of the primary filter. Filter No. 218, previously described, may also be considered as a secondary filter in a double filtration scheme, since it has always been operated with Lawrence water which has been filtered through the city filter.

Filter No. 244, $\frac{1}{20000}$ of an acre in area, was first put into operation Feb. 16, 1904, and during 1906 contained about 45 inches in depth of sand of an effective size of 0.23 millimeter. This filter was operated throughout the year with the effluent from Filter No. 220, during December the rate being 10,000,000 gallons, and after January 1, 20,000,000

gallons per acre daily. Notwithstanding the fact that this filter was operated with filtered water, it was necessary to scrape it seven times during the year. It was out of operation during the whole or part of the twenty-four hours on forty-three different days during the year.

Filter No. 286, 1/20000 of an acre in area and containing 42 inches in depth of mixed sand of an effective size of 0.21 millimeter, was first put into operation Jan. 20, 1906. This filter was operated with Merrimack River water at a rate of 5,000,000 gallons per acre daily until March 31, in order to establish a state of biological activity. After April 1, the effluent from Filter No. 219 was applied at a rate of 10,000,000 gallons per acre daily. During the period in which it was operated with river water it was necessary to scrape it twice, and on November 16, after operating seven and one-half months with filtered water, scraping was again necessary. Owing to an insufficient supply of filtered water, it was out of operation during the whole or part of the twenty-four hours on thirty-three different days during the year.

In the experiments on double filtration hitherto described, the practice was to operate the primary filter at a comparatively low rate and the secondary filter at a much higher rate. On December 1, two filters were put into operation, in which this practice was reversed, the primary Filter No. 280 being operated at a high rate to act as a sort of scrubber to remove the suspended matters from the water and concentrate the scraping upon a small proportion of the total filtering area, the secondary filter No. 281 being operated at a lower rate with the clarified water.

Filter No. 280, 1/20000 of an acre in area, contained 24 inches in depth of sand of an effective size of 0.28 millimeter. From Dec. 1, 1905, to Jan. 31, 1906, it was operated at a rate of about 5,000,000 gallons per acre daily with Merrimack River water. On February 1, the rate of operation was increased to 10,000,000 gallons per acre daily. It was scraped thirty-seven times during the year. On account of low water in the Essex Company's canal, it was out of operation on seventeen days for periods of twenty-four hours or less.

Filter No. 281, 1/10000 of an acre in area, contained 44 inches in depth of sand of an effective size of 0.24 millimeter. From Dec. 1, 1905, to Jan. 31, 1906, the Merrimack River water was applied to it at a rate of 5,000,000 gallons per acre daily, to get it into a condition of biological activity.

After Feb. 1, 1906, the effluent from Filter No. 280 was applied to this filter at a rate of 5,000,000 gallons per acre daily. During the period when the filter was operated with Merrimack River water, it was scraped three times, but not during the period when it was operated with the effluent from Filter No. 280. Owing to an insufficient supply of raw

water, it was out of operation during the whole or part of the twenty-four hours on fifty-eight different days during the year.

Considering the various double filtration systems as units, the combined rate of the Lawrence city filter and Filter No. 218 was about one million gallons per acre daily, and the water passed through an average depth of sand of about 7½ feet; the combined rate of Filters Nos. 220 and 244 was about two million gallons per acre daily during December and about four million gallons per acre daily during the remainder of the year, the water passing through a total depth of sand of about 7 feet; the combined rate of Filters Nos. 280 and 281 was about three and one-third million gallons per acre daily, the total depth of sand in the two filters was about 5 feet; and the combined rate of Filters Nos. 219 and 286 was about three and one-third million gallons per acre daily, with a total depth of sand of about 7 feet. Tables showing the chemical and bacterial analyses of the effluents of these filters and the efficiency of the individual filters and of the various double filtration systems follow.

*Effluent of Filter No. 244.*[1]

[Parts per 100,000.]

| | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. | | Ammonia. | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turbidity. | Color. | Free. | Total Albuminoid. | | Nitrates. | Nitrites. | | | |
| Average, . . | 17,821,000 | 55 | 0.0 | .30 | .0020 | .0095 | .33 | .026 | .0001 | .42 | 53.8 | 1.1 |

[1] For applied water see effluent of Filter No. 220.

*Bacteria in Applied Water, and Effluent of Filter No. 244.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. | |
|---|---|---|---|---|---|
| | Applied Water. | Effluent. | | 1 c.c. | 100 c.c. |
| **1905.** | | | | | |
| December, . . . . . . . | 80 | 53 | 33.7 | 7.7 | 92.3 |
| **1906.** | | | | | |
| January, . . . . . . . | 90 | 60 | 33.3 | 28.6 | 42.9 |
| February, . . . . . . . | 125 | 80 | 36.0 | 22.2 | 89.0 |
| March, . . . . . . . | 35 | 16 | 54.3 | 8.3 | 75.0 |
| April, . . . . . . . | 65 | 17 | 73.8 | 0.0 | 92.4 |
| May, . . . . . . . | 70 | 9 | 87.2 | 0.0 | 83.3 |
| June, . . . . . . . | 45 | 9 | 80.0 | 0.0 | 62.5 |
| July, . . . . . . . | 160 | 12 | 92.5 | 10.0 | 60.0 |
| August, . . . . . . . | 80 | 17 | 78.8 | 21.4 | 57.1 |
| September, . . . . . . | 46 | 42 | 8.7 | - | - |
| October, . . . . . . | 95 | 70 | 26.3 | - | - |
| November, . . . . . . | 30 | 27 | 10.0 | - | - |
| Average, . . . . . . | 75 | 34 | 51.2 | 10.9 | 72.7 |

*Effluent of Filter No. 286.*[1]

[Parts per 100,000.]

| | Quantity Applied. Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. Turbidity. | Appearance. Color. | Ammonia. Free. | Ammonia. Total Albuminoid. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, | 8,330,000 | 56 | 0.0 | .32 | .0558 | .0130 | .48 | .025 | .0007 | .45 | 45.8 | 1.4 |

[1] For applied water see effluent of Filter No. 219.

*Applied Water — Filter No. 286.*

[Average of Bacterial Analyses.]

| 1906. | Average Number of Bacteria per Cubic Centimeter. | Average Number of B. Coli per Cubic Centimeter. | Per Cent. of Samples containing B. Coli. |
|---|---|---|---|
| April, | 275 | - | - |
| May, | 750 | 21 | 100.0 |
| June, | 1,800 | 83 | 80.0 |
| July, | 2,000 | 4 | 77.8 |
| August, | 1,600 | 46 | 92.3 |
| September, | 5,200 | - | - |
| October, | 7,100 | - | - |
| November, | 4,800 | - | - |
| Average, | 2,900 | 39 | 87.5 |

*Effluent of Filter No. 286.*

[Average of Bacterial Analyses.]

| 1906. | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. 1 c.c. | Per Cent. of Samples containing B. Coli. 100 c.c. |
|---|---|---|---|---|
| January, | 4,000 | 15.0 | 100.0 | 75.0 |
| February, | 250 | 94.0 | 60.0 | 100.0 |
| March, | 39 | 98.6 | 8.3 | 66.7 |
| April, | 60 | 78.2 | 23.1 | 69.3 |
| May, | 900 | - | 10.0 | 80.0 |
| June, | 630 | 65.0 | 30.0 | 50.0 |
| July, | 1,000 | 50.0 | 11.1 | 89.0 |
| August, | 2,200 | - | 38.4 | 53.8 |
| September, | 2,700 | 48.1 | - | - |
| October, | 4,000 | 43.7 | - | - |
| November, | 3,600 | 16.3 | - | - |
| Average, | 1,800 | 56.5 | 35.1 | 73.0 |

*Effluent of Filter No. 280.*[1]

[Parts per 100,000.]

| | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. — Turbidity. | Appearance. — Color. | Ammonia. — Free. | Ammonia. — Total Albuminoid. | Chlorine. | Nitrogen as — Nitrates. | Nitrogen as — Nitrites. | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, . | 8,740,700 | 56 | 0.0 | .34 | .0080 | .0130 | .33 | .024 | .0005 | .48 | 50.6 | 1.1 |

[1] River water applied.

*Effluent of Filter No. 280.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. — 1 c.c. | Per Cent. of Samples containing B. Coli. — 100 c.c. |
|---|---|---|---|---|
| **1905.** | | | | |
| December, | 4,000 | 36.5 | 25.0 | 91.7 |
| **1906.** | | | | |
| January, | 180 | 97.2 | 36.4 | 81.8 |
| February, | 600 | 85.7 | 55.6 | 66.7 |
| March, | 60 | 97.8 | 33.3 | 83.5 |
| April, | 55 | 97.7 | 10.0 | 70.0 |
| May, | 325 | 94.4 | 40.0 | 70.0 |
| June, | 48 | 99.3 | 18.2 | 66.7 |
| July, | 55 | 99.1 | 42.9 | 85.8 |
| August, | 245 | 95.6 | 50.0 | 64.2 |
| September, | 80 | 98.8 | - | - |
| October, | 275 | 96.3 | - | - |
| November, | 54 | 97.2 | - | - |
| Average, | 500 | 91.3 | 34.6 | 75.6 |

*Effluent of Filter No. 281.*[1]

[Parts per 100,000.]

| | Quantity Applied. — Gallons per Acre Daily for Six Days in a Week. | Temperature (Deg. F.). | Appearance. — Turbidity. | Appearance. — Color. | Ammonia. — Free. | Ammonia. — Total Albuminoid. | Chlorine. | Nitrogen as — Nitrates. | Nitrogen as — Nitrites. | Oxygen Consumed. | Dissolved Oxygen (Per Cent. of Saturation). | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average, . | 4,781,000 | 54 | 0.0 | .31 | .0045 | .0104 | .344 | .026 | .0002 | .45 | 48.2 | 1.1 |

[1] Applied water, effluent of Filter No. 280.

### *Applied Water — Filter No. 281.*

[Average of Bacterial Analyses.]

| 1906. | Average Number of Bacteria per Cubic Centimeter. | Average Number of B. Coli per Cubic Centimeter. | Per Cent. of Samples containing B. Coli. |
|---|---|---|---|
| February, | 1,000 | - | - |
| March, | 65 | - | - |
| April, | 90 | - | - |
| May, | 275 | 10 | 89.0 |
| June, | 85 | 26 | 91.0 |
| July, | 110 | 11 | 83.3 |
| August, | 190 | 20 | 100.0 |
| September, | 95 | - | - |
| October, | 275 | - | - |
| November, | 435 | - | - |
| Average, | 260 | 17 | 90.8 |

### *Effluent of Filter No. 281.*

[Average of Bacterial Analyses.]

| Date. | Average Number of Bacteria per Cubic Centimeter. | Per Cent. removed (Efficiency). | Per Cent. of Samples containing B. Coli. | |
|---|---|---|---|---|
| | | | 1 c.c. | 100 c.c. |
| **1905.** | | | | |
| December, | 475 | 92.5 | 54.5 | 91.0 |
| **1906.** | | | | |
| January, | 140 | 97.0 | 36.4 | 81.8 |
| February, | 110 | 89.0 | 22.2 | 77.8 |
| March, | 28 | 57.0 | 0.0 | 91.7 |
| April, | 30 | 66.7 | 11.1 | 77.7 |
| May, | 25 | 90.9 | 0.0 | 80.0 |
| June, | 16 | 81.2 | 0.0 | 75.0 |
| July, | 250 | - | 42.9 | 57.2 |
| August, | 29 | 84.7 | 14.3 | 50.0 |
| September, | 15 | 84.2 | - | - |
| October, | 18 | 93.5 | - | - |
| November, | 11 | 97.5 | - | - |
| Average, | 95 | 84.9 | 20.2 | 75.8 |

*Table showing Percentage Removal of Bacteria by Double Filtration System.*

| Date. | Lawrence City Filter and Filter No. 218. | Filter No. 220 and Filter No. 244. | Filter No. 280 and Filter No. 281. | Filter No. 219 and Filter No. 286. |
|---|---|---|---|---|
| **1905.** | | | | |
| December, | 99.9 | 99.2 | - | - |
| **1906.** | | | | |
| January, | 99.9 | 98.7 | - | - |
| February, | 99.9 | 98.1 | 97.4 | - |
| March, | 99.9 | 99.4 | 99.0 | - |
| April, | 99.7 | 99.8 | 98.7 | 99.6 |
| May, | 99.8 | 99.8 | 99.6 | 92.5 |
| June, | 99.0 | 99.9 | 99.8 | 94.5 |
| July, | 99.9 | 99.8 | 95.8 | 96.0 |
| August, | 99.6 | 99.7 | 99.5 | 73.8 |
| September, | 99.7 | 99.4 | 99.8 | 94.3 |
| October, | 99.9 | 99.1 | 99.8 | 93.5 |
| November, | 99.8 | 98.6 | 99.4 | 92.2 |
| Average, | 99.7 | 99.2 | 98.9 | 92.1 |

## Mechanical Filtration.

### *Filter No. 216.*

This filter, 1/10000 of an acre in area and containing 15 inches in depth of sand of an effective size of 0.60 millimeter, was first put into operation during 1903, and was continued in operation as a mechanical filter during 1906, receiving canal water after treatment with sulphate of alumina and a period of sedimentation. The filter was not operated during the period from Dec. 1, 1905, to March 1, 1906. During February, it was raised in order to allow it to be operated with a greater loss of head than during previous years, and sufficient washed sand of an effective size of 0.71 millimeter was placed in the tank to make a total depth of sand of 21 inches. An additional settling tank was also added to the system. Beginning March 4 and continuing throughout the year, it was operated at a rate of 75,000,000 gallons per acre daily. During past years, attempts have been made to operate this filter with the addition of sulphate of alumina without soda, and to wash at stated periods. During the present year, sufficient soda has been added to the water to maintain an alkaline effluent at all times, and at all times to keep the amount of chemicals to the lowest possible amount consistent with maintaining an effluent of good quality. Sulphate of alumina

was added at different times during the year in amounts varying from 0.6 of a grain to 2.1 grains per gallon, and soda ash in amounts varying from 0.3 of a grain to 1.7 grains per gallon. The cost of chemicals, given in the tables below, has been based upon sulphate of alumina and soda ash, each at $20 per ton. The filter was washed whenever the loss of head increased to such an amount that a diminution of the rate occurred, that is to say, the practice of operation of mechanical filters on a large scale was followed as closely as possible.

With the filter operated at the above rate, the period which elapsed between the addition of the chemicals and the passage of the water from the sedimentation tanks to the surface of the filter was about one hour.

Good mechanical filter practice requires that the wash water be passed through the sand at a rate of about 6 gallons per minute per square foot of surface area, and the average time required to wash well-constructed filters is about fifteen minutes. The time required to wash Filter No. 216 has also been about fifteen minutes, but the filter has been arranged in such a manner that measurements of the amount of wash water could not readily be made. For this reason, the per cent. of wash water, as given in the tables below, has been based upon the average amount required for filters in use at other places.

The bacterial efficiency of the filter, even with the larger amounts of sulphate of alumina and soda, was not equal to that of water filters of other types.

*Table showing Rate, Gallons filtered between Washings and Amount of Coagulant.*

*Filter No. 216.*

| Number of Runs. | Period of Operation. 1906. | Time between Washings (Hours). | Million Gallons per Acre. | | Chemicals applied (Grains per Gallon). | |
|---|---|---|---|---|---|---|
| | | | Per 24 Hours. | Between Washings. | Sulphate of Alumina. | Soda Ash. |
| 1 to 5, . . | March 1 to 17, . | 29.93 | 78.63 | 96.15 | 0.59 | 0.30 |
| 6 to 15, . . | March 18 to 29, . | 10.00 | 79.11 | 32.99 | 0.92 | 0.45 |
| 16 to 30, . . | April 2 to 11, . . | 5.47 | 77.61 | 17.68 | 1.39 | 0.94 |
| 31 to 64, . . | April 12 to June 22, | 9.85 | 79.17 | 32.49 | 1.39 | 1.05 |
| 65 to 67, . . | June 23 to 30, . . | 17.62 | 79.17 | 58.12 | 1.61 | 1.40 |
| 68 to 119, . . | July 2 to Sept. 8, . | 8.65 | 79.47 | 28.65 | 1.74 | 1.56 |
| 120 to 190, . . | Sept. 11 to Nov. 30, | 5.75 | 72.91 | 17.46 | 2.14 | 1.66 |

### *Analyses of Applied Water and Effluent during Different Runs.*

*Merrimack River Water applied to Filter No. 216.*

[Parts per 100,000.]

| Number of Runs. | Color. | Ammonia. | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Albuminoid. | | | | | | |
| | | Free. | Total. | In Solution. | | Nitrates. | Nitrites. | | |
| 1 to 5, . . . | .37 | .0054 | .0174 | .0138 | .29 | .009 | .0002 | .51 | 1.0 |
| 6 to 15, . . . | .31 | .0070 | .0136 | - | .38 | .012 | .0000 | .59 | 1.1 |
| 16 to 30, . . . | .34 | .0048 | .0126 | .0112 | .11 | .009 | .0000 | .37 | 0.9 |
| 31 to 64, . . . | .42 | .0058 | .0161 | .0135 | .12 | .014 | .0004 | .50 | 0.9 |
| 65 to 67, . . . | .55 | - | - | - | - | - | - | - | 1.1 |
| 68 to 119, . . . | .49 | .0173 | .0194 | .0171 | .38 | .016 | .0004 | .53 | 1.3 |
| 120 to 190, . . . | .36 | .0268 | .0215 | .0190 | .56 | .015 | .0011 | .61 | 1.3 |

*Effluent of Filter No. 216.*

| Number of Runs. | Color. | Free. | Total. | In Solution. | Chlorine. | Nitrates. | Nitrites. | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|
| 1 to 5, . . . | .37 | .0054 | .0138 | - | .28 | .013 | .0002 | .41 | 0.8 |
| 6 to 15, . . . | .19 | .0082 | .0118 | - | .46 | .011 | .0002 | .41 | 0.9 |
| 16 to 30, . . . | .08 | .0050 | .0032 | - | .07 | .007 | .0002 | .13 | 0.6 |
| 31 to 64, . . . | .15 | .0069 | .0091 | - | .25 | .014 | .0003 | .24 | 0.8 |
| 65 to 67, . . . | .39 | - | - | - | - | - | - | - | 1.1 |
| 68 to 119, . . . | .13 | .0174 | .0105 | - | .39 | .013 | .0003 | .23 | 1.1 |
| 120 to 190, . . . | .08 | .0263 | .0115 | - | .56 | .017 | .0007 | .22 | 1.0 |

### *Removal of Coloring and Organic Matter — Filter No. 216.*

| Number of Runs. | Per Cent. of Color removed. | Per Cent. of Organic Matter removed. | | Per Cent. of Bacteria removed by | | | Per Cent. of B. Coli removed by Coagulation and Sedimentation. |
|---|---|---|---|---|---|---|---|
| | | From Albuminoid Ammonia. | From Oxygen consumed. | Coagulation and Sedimentation. | The Filter. | The System. | |
| 1 to 5, . | 0.0 | 20.6 | 19.5 | 0.0 | 47.6 | 47.7 | 20.8 |
| 6 to 15, . | 38.7 | 13.2 | 30.5 | 30.5 | 74.4 | 82.3 | 58.3 |
| 16 to 30, . | 76.5 | 74.6 | 64.8 | 43.2 | 88.6 | 98.5 | 35.3 |
| 31 to 64, . | 64.3 | 43.5 | 52.0 | 75.0 | 93.3 | 98.3 | 56.0 |
| 65 to 67, . | 29.0 | - | - | 93.6 | 85.0 | 99.0 | 58.4 |
| 68 to 119, . | 73.5 | 45.9 | 56.6 | 89.1 | 92.9 | 99.2 | 84.1 |
| 120 to 190, . | 77.8 | 46.6 | 63.9 | 63.7 | 95.9 | 98.7 | - |

*Bacterial Results.*

*Filter No. 216.*

| Number of Runs. | Average Number of Bacteria per Cubic Centimeter. | | | Average Number of B. Coli per Cubic Centimeter. | | Effluent of Filter (Per Cent. of Samples containing B. Coli.) | |
|---|---|---|---|---|---|---|---|
| | Raw Water. | Effluent from Settling Tank. | Effluent from Filter. | Raw Water. | Effluent from Settling Tank. | 1 c.c. | 100 c.c. |
| 1 to 5, | 2,100 | 2,100 | 1,100 | 48 | 38 | 33.3 | 41.7 |
| 6 to 15, | 3,600 | 2,500 | 640 | 48 | 20 | 30.0 | 80.0 |
| 16 to 30, | 3,700 | 2,100 | 240 | 17 | 11 | 11.1 | 55.5 |
| 31 to 64, | 4,800 | 1,200 | 80 | 93 | 41 | 28.2 | 77.0 |
| 65 to 67, | 15,700 | 1,000 | 150 | 161 | 67 | 28.6 | 14.3 |
| 68 to 119, | 15,600 | 1,700 | 120 | 577 | 92 | 42.8 | 57.1 |
| 120 to 190, | 5,200 | 1,700 | 70 | - | - | - | - |

*Cost of Chemicals.*

*Filter No. 216.*

| Number of Runs. | Per Cent. Wash Water was of Total Volume filtered. | Cost of Chemicals per Million Gallons filtered. | | | Cost of Chemicals per Million Gallons Available for Use. |
|---|---|---|---|---|---|
| | | Sulphate of Alumina. | Soda Ash. | Total. | |
| 1 to 5 inclusive, | 4.0 | $0 84 | $0 43 | $1 27 | $1 32 |
| 6 to 15 " | 11.9 | 1 33 | 0 64 | 1 97 | 2 24 |
| 16 to 30 " | 22.1 | 1 99 | 1 39 | 3 38 | 4 33 |
| 31 to 64 " | 12.0 | 1 99 | 1 50 | 3 49 | 3 97 |
| 65 to 67 " | 6.7 | 2 30 | 2 00 | 4 30 | 4 62 |
| 68 to 119 " | 13.7 | 2 49 | 2 23 | 4 72 | 5 46 |
| 120 to 190 " | 22.4 | 3 06 | 2 38 | 5 44 | 7 00 |

### *Relative Efficiency of Mechanical and Slow Sand Filters.*

It is usual, when discussing the work of different water filters, to base the relative efficiency of such filters upon the percentage removal of bacteria, that removal being computed from the averages of a considerable number of analytical determinations. When filtering waters as badly polluted as the Merrimack River water, a bacterial efficiency approximating 99 per cent. should be attained, and an average removal of less than 97 per cent. of the bacteria is unsatisfactory. It may occasionally happen, however, that, through certain features in the methods of operating filters, through the agencies of scraping slow sand filters and

improper application of chemicals in mechanical filters, the removal of bacteria may fall far below the efficiency required. Such a lapse, if for a few days only, would not seriously affect the average efficiency computed for a considerable period. Nevertheless, in a water intended for domestic consumption, the failure of the filter properly to remove the bacteria for a day might be attended with serious injury to the health of the community to which the water is supplied. The element of danger from poor handling is less with slow sand filters than with mechanical filters, the former depending for their efficiency upon natural agencies not likely to be affected by ordinary disturbances, and the latter depending on correct hourly treatment. Some data have been collected in the following table bearing on this phase of the water filtration problem, the results covering thirteen different experimental filters and two large filtration systems. In every case the period selected for comparison has been such that each filter was being operated under normal conditions, all analytical results obtained during the period being included in the computations. From the figures in this table it is readily seen that the bacterial efficiency of all of these filters was at times low. The fluctuations in the daily efficiency were less, however, for the slow sand filters than for the mechanical filters. Taking the results of the two types of filters collectively, the slow sand filters had an efficiency of more than 99 per cent., 42 per cent. of the time; of more than 98 per cent., 64 per cent. of the time; and below 95 per cent., 13 per cent. of the time; while the mechanical filters had an efficiency of 99 per cent., or more, 32 per cent. of the time; of more than 98 per cent., 49 per cent. of the time; and of less than 95 per cent., 28 per cent. of the time.

*Comparison of Bacterial Removal by Some Water Filters of Various Types.*

*Slow Sand Filters.*

| | Period. | Number of Analyses. | Per Cent. of Analyses showing a Bacterial Efficiency of | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | More than 99 Per Cent. | Between 98 and 99 Per Cent. | Between 97 and 98 Per Cent. | Between 96 and 97 Per Cent. | Between 95 and 96 Per Cent. | Between 90 and 95 Per Cent. | Less than 90 Per Cent. |
| Filter No. 8, before refilling, | Jan. 1, 1906, to April 9, 1906, inclusive. | 38 | 37 | 26 | 5 | 17 | 5 | 8 | 3 |
| Filter No. 8, after refilling, | May 26 to Aug. 31, 1906, inclusive. | 63 | 63 | 22 | 6 | 2 | 0 | 3 | 3 |
| Lawrence city filter, . . | Jan. 1, 1905, to Aug. 31, 1906, inclusive. | 292 | 77 | 16 | 2 | 0 | 2 | 1 | 2 |
| Filter No. 219, . . . | Jan. 1, to Aug. 31, 1906, inclusive. | 88 | 65 | 14 | 8 | 3 | 3 | 2 | 5 |
| Filter No. 230, . . . | Dec. 1, 1905, to Aug. 31, 1906, inclusive. | 89 | 17 | 28 | 13 | 10 | 5 | 11 | 16 |
| Washington, Experimental Filter A. | Dec., 1899, to Feb., 1900, inclusive. | 85 | 26 | 29 | 21 | 7 | 5 | 10 | 2 |
| Cincinnati, Experimental Filter No. 14. | April to Sept., 1898, inclusive. | 150 | 6 | 17 | 17 | 13 | 11 | 22 | 14 |

*Comparison of Bacterial Removal by Some Water Filters of Various Types* — Concluded.

*Mechanical Filters.*

| | Period. | Number of Analyses. | Per Cent. of Analyses showing a Bacterial Efficiency of | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | More than 99 Per Cent. | Between 98 and 99 Per Cent. | Between 97 and 98 Per Cent. | Between 96 and 97 Per Cent. | Between 95 and 96 Per Cent. | Between 90 and 95 Per Cent. | Less than 90 Per Cent. |
| Filter No. 216, . . . | Jan. to Aug., 1906, inclusive. | 114 | 37 | 14 | 7 | 4 | 7 | 9 | 22 |
| Washington, Experimental Filter B. | Dec. to Feb., 1900, inclusive. | 61 | 46 | 11 | 8 | 8 | 5 | 7 | 15 |
| Cincinnati, Experimental Jewell Filter. | Oct. 1, 1898, to Jan. 25, 1899, inclusive. | 201 | 35 | 23 | 17 | 8 | 4 | 5 | 8 |
| Pittsburgh, Experimental Jewell Filter. | Feb., March, April, July and Aug., 1898. | 141 | 21 | 23 | 15 | 14 | 10 | 9 | 8 |
| Pittsburgh, Experimental Warren Filter. | Feb., March, July and Aug., 1898. | 108 | 43 | 24 | 6 | 11 | 6 | 5 | 5 |
| New Orleans, Experimental Filter No. 3. | Jan. to Aug., 1901, . . | 290 | 14 | 8 | 6 | 7 | 9 | 25 | 31 |
| New Orleans, Experimental Filter No. 4. | Jan. to Aug., 1901, . . | 331 | 21 | 9 | 10 | 4 | 8 | 17 | 31 |
| Little Falls, . . . . | Mar., 1903, and Oct., 1904, | 62 | 37 | 23 | 5 | 6 | 6 | 18 | 5 |

## *Filter No. 317.*

This filter, $1/20000$ of an acre in area, and containing 10 feet in depth of sand of an effective size of 0.25 millimeter, was started Oct. 11, 1906, to study the effect of operating a filter containing a considerable depth of sand at a high rate with a very polluted water. From October 11 to October 14, inclusive, Merrimack River water was applied, and from October 15 to November 30, inclusive, the applied water consisted of river water, with 8 per cent. by volume of strained sewage. The filter was operated at a rate of 7,500,000 gallons per acre daily, and was scraped once during the short period of its operation.

# SIGNIFICANCE OF THE NUMBERS OF BACTERIA

IN

# WATER AND SEWAGE DEVELOPING AT DIFFERENT TEMPERATURES.

By STEPHEN DEM. GAGE,

*Biologist at the Lawrence Experiment Station.*

# ON THE SIGNIFICANCE OF THE NUMBERS OF BACTERIA IN WATER AND SEWAGE DEVELOPING AT DIFFERENT TEMPERATURES.

By STEPHEN DEM. GAGE,
*Biologist at the Lawrence Experiment Station.*

With the inception of bacterial methods of water analysis it was believed that a determination of the numbers of bacteria would prove a good index to the character of a water. As the variety of bacteria in waters has become better understood, however, it has come to be recognized that the counts of the number of bacteria developing on gelatin or agar plates, while usually indicating in some measure whether the water is good or bad, are occasionally entirely at variance with the facts. Determinations of specific types of bacteria, such as the colon, sporogenes and sewage streptococcus groups, have proved of very great value in aiding us to make a correct interpretation of our bacterial counts, but even these tests are not infallible, and may at times lead us into error.

The chemist makes determinations of six or more different factors, and knowing the influence which pollution may exert on each factor, and upon their relation to one another, he is able to make an interpretation of the significance of the complete analysis with a considerable degree of accuracy. On the other hand, the bacteriologist usually determines collectively the number of bacteria, and perhaps makes a qualitative test for some one type. Should the chemist confine himself to a determination of the total nitrogen in a sample, instead of expressing that element in terms of albuminoid ammonia, free ammonia, nitrates and nitrites, with perhaps an additional qualitative test for chlorine, his interpretation would be on much the same plane as that of the bacteriologist. He would still have one advantage, however, in that he could complete his analysis and arrive at some sort of a conclusion within a few hours after the sample was received, while the determinations of bacteria would require some days. In order that the bacterial determinations may reach the same plane of usefulness as the chemical analysis, it is essential that the procedures be so modified that they shall yield more complete information

regarding the various kinds of bacteria in the water under examination, and that they shall yield that information within a reasonably short time.

As in many other water laboratories, this subject has received serious consideration at the Lawrence Experiment Station during the past fifteen years, and the results of many investigations bearing on one phase or another of the problem have been reported from time to time. It is the belief of the writer that the ultimate solution of the problem will come through the classification of the bacteria in water into groups by the selective action of different media and different temperatures, and it is proposed to report here the results of some recent investigations upon the value of determinations of the numbers of bacteria by counts of agar and litmus-lactose-agar plates incubated for short periods at temperatures of 20°, 30°, 40° and 50°C.

The determination of numbers of bacteria on gelatin or agar plates, incubated at room temperature, is the usual practice. Determinations of the numbers developing at 40° are beginning to be used as their significance becomes better understood. A few investigations have been made of the occurrence and numbers of bacteria in water and sewage which are able to develop at 50°C. and above, but up to the present time little practical application has been made of such procedure. No comprehensive study of the numbers of bacteria in different classes of waters which are able to develop on plates incubated at 30°C. has been reported, although it is reasonable to suppose that such a temperature would prove favorable for the growth of a large proportion of the total bacteria during a short period of incubation.

The use of litmus-lactose-agar in connection with, or as a substitute for, the ordinary gelatin or agar in the determination of numbers of bacteria is slowly gaining a foothold in many laboratories, its advantage being that it permits a distinction to be made between the types of bacteria which do and do not produce acid fermentation of lactose. In the investigations recorded further on, both agar and litmus-lactose-agar plates were incubated at all temperatures, but the total numbers of bacteria were so nearly alike in all cases that the numbers appearing on the agar plates have been omitted in many cases. Owing to the slow growth of bacteria at 20°C. it is impossible to obtain counts in less than forty-eight hours on plates incubated at that temperature, and it is usual to employ an incubation period of three to four days; and at Lawrence it has always been the custom to incubate the plates for four days.

With the use of higher temperatures, and the more rapid growth of bacteria at such temperatures, it becomes possible to adopt a shorter period of incubation. Since the aim of the investigation has been to make the results of bacterial determinations available at the earliest possi-

ble moment, a uniform incubation of twenty-four hours on all plates grown at temperatures higher than 20°C. has been adopted, consequently the numbers of bacteria included in the discussion and tables beyond, unless otherwise stated, were obtained on plates incubated four days at 20°C., and twenty-four hours at 30°, 40° and 50°C. respectively.

In comparing the analytical results obtained from different waters, or from different samples of the same water, it is usual to express the results of such comparison as the proportion which exists between the two. The mathematical expression of the ratios between the results of different determinations is less common, and has hitherto been confined to the chemical side of the analysis. That the time required to compute such ratios is well repaid by the additional information which they may convey will be shown further on.

The data used in the discussion and tables have been obtained in part by recomputation of certain of the routine results obtained during the past nine years and in part from special studies of the relative counts of bacteria obtained on plates incubated at different temperatures. In addition to the incubators regularly operated at 20°C. and 40°C., we have one spare incubator, which has been operated part of the time at 30°C. and part of the time at 50°C. In considering the significance of the numbers of bacteria and the numbers of acid-producing bacteria determined at the different temperatures, it is therefore necessary to divide the results into two series. The two experiments covered much the same classes of water, and included determinations at 20°C. and at 40°C. of bacteria and acid-producers common to both experiments. No direct comparison, however, was possible between the results obtained at 30°C. and 50°C., and we are forced to make such a comparison indirectly through the counts at 20°C. and 40°C. It should be further borne in mind that, while the series containing the 50°C. counts covered a wide range of samples, only 5 samples were used from each of the several sources, and these samples were all collected within a limited period of time. For this reason the results of this series, while indicative of the results which might be obtained in practice, should not be taken as conclusive evidence of the value of the 50° counts. On the other hand, the results obtained in the 30° series, while covering a smaller range of waters, were obtained from the examination of over 400 samples, collected during a period of many months.

Determinations of the numbers of bacteria producing acid fermentation of lactose at 40°C. in twenty-four hours have been made a part of the routine analyses of polluted waters during the past nine years, the results of these determinations being reported as the number of B. coli, although strictly speaking only about 80 to 90 per cent. of such bacteria

are of the colon type. During the past two years, counts of the total number of bacteria developing in twenty-four hours at 40°C. have been recorded, and during 1906 determinations at both 20° and 40° have been made on a considerable proportion of all samples. A description of the various sewages, waters and effluents from sewage and water filters employed in the investigation is contained in the chapters on "Sewage" and "Water Purification" and it is unnecessary that they be reproduced here. Under the title of "Ponds" are included numerous samples from two large ponds, both of which are used for water supply. The watersheds of both of these ponds are under sanitary control, but both are used more or less for pleasure purposes in the summer, and are subject to occasional contamination. The driven-well samples were from two series of wells, less than 50 feet deep, used as water supply. Under "Shallow Wells" are included samples from 15 different wells, the results from both good and polluted wells being averaged. In tables where results from two wells are given, "No. 1" is of excellent quality, while "No. 2" is badly polluted. Samples from two different springs, both of good quality, are included.

### Relative Numbers of Bacteria at 20°, 30°, 40° and 50°C.

In Table No. 1 are shown the average numbers of bacteria and of acid-producers obtained with different waters on plates incubated at 20°C., 30°C. and 40°C. From the figures in this table it is seen that the numbers obtained at the different temperatures agree in general with the character of the water under examination. The counts obtained at 30° were larger than those at 40° in every instance when dealing with polluted water, but there was little difference in these counts when dealing with water of good quality. This fact, however, would be an advantage rather than otherwise, since the use of 30° counts would give us a much sharper distinction between good and bad waters than would counts at 40°, and would allow this distinction to be made in a minimum time, twenty-four hours, as compared with two to four days required to obtain the 20° counts.

The average numbers of bacteria and the numbers of acid-producers determined at 20°, 40° and 50° on 5 samples each from 26 different sources are shown in Table No. 2. In general the numbers of bacteria at 20° and 40°, and the numbers of acid-producers determined at those temperatures, are large or small as the water is polluted or non-polluted, confirming the findings previously discussed under the 30° series. The most significant results are those obtained for the two shallow wells. The number of bacteria determined at 20° is higher in Well No. 1 than in Well No. 2. Well No. 2 is in a thickly settled community, with vaults

and cesspools in close proximity, while Well No. 1, situated in an open field upon the top of a hill, is removed from any chance of pollution. Chemical analyses extending over a period of some years indicate that Well No. 1 is free from pollution, and that Well No. 2 is seriously polluted. The sanitary survey and chemical analyses are confirmed by the bacterial count at 40° and by the numbers of acid-producers developing at 20° and 40°, showing that the large numbers of bacteria determined at 20° in Well No. 1 are of a harmless character.

The numbers of bacteria and the acid-formers determined at 50°C. confirm the results of determinations at 20° and 40°, but the distinction between different classes of waters is more marked than by determinations at the lower temperatures. It is noticeable that the 50° bacteria in the effluents from the contact Filters Nos. 175 and 176 were higher than in the regular sewage which was applied to those filters, and the numbers in the effluent of contact Filter No. 251 were larger than in the septic sewage with which it was operated. On the other hand, the numbers in the effluents from the trickling filters were small, and this type of bacteria was either entirely lacking, or present in insignificant numbers, in the effluents from the sand filters. The distinction between the river water and the filtered waters is not very well marked, but a class distinction between the river water and the filtered river waters, and the ponds, wells and springs, is indicated by the entire absence of this type of organisms in the latter class of waters. The occurrence of 50° acid-producing bacteria is also significant, this type of organisms being absent from the effluents from three out of four of the intermittent sewage filters, and practically absent from the fourth, while they were present in greater or smaller numbers in the sewages and in the effluents from the contact and trickling filters through which the sewage passed more rapidly. The presence of such small numbers of this type of bacteria in the polluted river water, and of similar numbers in the effluents from the primary water filters, cannot be accounted for at the present time.

We have learned by past experience that nearly all of the bacteria capable of forming colonies at 20°C. will manifest themselves in four days, this being also true of the acid-producing bacteria. In general, sources which are polluted show maximum growth in two days at 20° in 20 to 40 per cent. of the samples, while none of the samples of purer waters show maximum growth until the third day or later. There are some exceptions to this rule, and a small percentage of samples of both classes may not show maximum growth until the seventh day or later. At 40°C. and 50°C. nearly all the bacteria and acid-producers capable of developing at these temperatures are shown by a count made after twenty-four hours. At 30°C., however, our twenty-four-hour counts show us only

30 to 50 per cent. of the bacteria which would be able to produce colonies if the period of incubation were increased to two or three days. The results of determinations of acid-producing bacteria at 20° divide themselves naturally into groups. All of the samples of sewage and effluents from sewage filters, and over 80 per cent. of the polluted waters and effluents from sewage filters, contained bacteria of this type, the percentage for shallow wells dropping to 70, for pond water to 60, and for deep wells to 40. The springs differed from the other relatively pure waters in that all samples contained acid-producing bacteria. At 30°C. the percentage of samples showing growth and acid-producing bacteria is generally indicative of the quality of the water, becoming less as the quality of the water improves. The same rule holds for the determinations made at 40°C., the distinction between samples known to have been polluted recently, even although they have been subjected to purification, and samples from sources whose chance of pollution is more remote, being especially well marked. The driven-well waters showed entire absence of bacteria growing at this temperature. The distinction between sewage and polluted water before filtration, and the effluents from sewage and water filters, is shown by the smaller per cent. of samples from the filtered sources which contain bacteria and acid-producing organisms capable of developing at 50°C. Bacteria of these types occurred only in a small percentage of the samples from ponds and shallow wells, and were entirely absent from samples from springs and driven wells.

TABLE No. 1.—*Average Number of Bacteria and Acid-Producers developing at 20°, 30° and 40°C., with Different Classes of Water.*

| | BACTERIA PER CUBIC CENTIMETER. | | | ACID-PRODUCING BACTERIA. | | |
|---|---|---|---|---|---|---|
| | 20° C. (4 Days). | 30° C. (24 Hours). | 40° C. (24 Hours). | 20° C. (4 Days). | 30° C. (24 Hours). | 40° C. (24 Hours). |
| Canal, | 4,100 | 450 | 81 | 940 | 142 | 44 |
| Intake, | 5,000 | 619 | 122 | 660 | 173 | 42 |
| Applied 216, | 2,000 | 203 | 46 | 537 | 55 | 26 |
| Filter No. 216, | 180 | 8 | 7 | 27 | 3 | 5 |
| Filter No. 220, | 80 | 18 | 5 | 11 | 2 | 1 |
| City filter, | 23 | 2 | 4 | 6 | 1 | 2 |
| Pond No. 1, | 12 | 0 | 1 | 2 | 0 | 0 |
| Pond No. 2, | 17 | 1 | 1 | 1 | 0 | 1 |

TABLE No. 2. — *Average Number of Bacteria and Acid-Producers developing at 20°, 40° and 50° C., with Different Classes of Water.*

| | Bacteria per Cubic Centimeter. | | | Acid-producing Bacteria. | | |
|---|---|---|---|---|---|---|
| | 20° C. (4 Days). | 40° C. (24 Hours). | 50° C. (24 Hours). | 20° C. (4 Days). | 40° C. (24 Hours). | 50° C. (24 Hours). |
| Regular sewage, | 2,990,000 | 557,500 | 7,700 | 1,940,000 | 346,000 | 4,400 |
| Station sewage, | 1,676,000 | 360,000 | 29,500 | 1,032,000 | 283,000 | 24,900 |
| Septic sewage, | 485,000 | 126,500 | 410 | 241,000 | 90,000 | 240 |
| Sand filters: — | | | | | | |
| No. 1, | 1,640 | 1,375 | 2 | 2,360 | 1,195 | 1 |
| No. 2, | 35 | 4 | 0 | 29 | 2 | 0 |
| No. 4, | 1,300 | 130 | 1 | 345 | 119 | 0 |
| No. 9, | 670 | 170 | 2 | 1,045 | 154 | 0 |
| Trickling filters: — | | | | | | |
| No. 135, | 15,500 | 1,730 | 154 | 15,200 | 1,360 | 100 |
| No. 136, | 23,300 | 2,080 | 54 | 16,000 | 1,180 | 20 |
| Contact filters: — | | | | | | |
| No. 175, | 146,600 | 26,100 | 8,300 | 112,400 | 22,700 | 8,000 |
| No. 176, | 389,000 | 59,300 | 8,000 | 292,000 | 45,000 | 8,000 |
| No. 251, | 306,000 | 89,600 | 485 | 198,000 | 46,000 | 200 |
| Canal, | 16,400 | 112 | 5 | 6,700 | 87 | 2 |
| Intake, | 16,900 | 207 | 4 | 2,500 | 134 | 2 |
| Applied 216, | 2,800 | 212 | 2 | 1,650 | 66 | 1 |
| Filter No. 8, | 32 | 3 | 1 | 6 | 1 | 1 |
| Filter No. 216, | 715 | 170 | 2 | 259 | 101 | 1 |
| Filter No. 243, | 62 | 1 | 0 | 16 | 0 | 0 |
| City filter, | 150 | 22 | 1 | 14 | 17 | 1 |
| City water, | 64 | 5 | 1 | 11 | 3 | 1 |
| Pond No. 1, | 27 | 1 | 0 | 8 | 1 | 0 |
| Pond No. 2, | 71 | 8 | 0 | 30 | 5 | 0 |
| Driven wells, | 41 | 0 | 0 | 0 | 0 | 0 |
| Shallow Well No. 1, | 1,000 | 2 | 0 | 3 | 1 | 0 |
| Shallow Well No. 2, | 507 | 72 | 0 | 82 | 55 | 0 |
| Spring No. 1, | 49 | 0 | 0 | 6 | 0 | 0 |
| Spring No. 2, | 30 | 2 | 0 | 8 | 2 | 0 |

In Table No. 3 are shown the various bacterial ratios for the determinations at 20°, 30° and 40° C. Certain distinctions between the different waters are brought out by these ratios which do not appear in the numbers of bacteria. In the first two columns are shown the per cent. which the numbers of bacteria determined at 30° and 40° after twenty-four hours' incubation are of the total bacteria determined at 20° after four days' incubation. From these figures we see that, with one exception, a much greater percentage of the total bacteria is determined at 30° for polluted waters than for the pure waters; that is to say, the distinction between pure and polluted waters is emphasized by the 30° counts. On the other hand, the distinction is less marked with the counts at 40°, as is shown by the fact that the ratios are greater for the good waters than for the polluted waters. If we assume that the presence of bacteria capable of rapid growth at 40 degrees is an indication that a water contains sewage bacteria, the fact that the proportion which such bacteria form of the total number present is greater in good than in polluted waters might signify that bacteria of this type are less completely removed by filtration than other bacteria present in the unfiltered water. The efficiency of filtration is well proved, however, at the present time.

No such lesson is apparent in the ratios between the total bacteria at 20° and the acid-producing bacteria at 30° and 40°, the values for the raw waters and filtered waters being much the same. A sharp distinction is noted between the ponds and the other samples in the 30° values, although this distinction does not appear in the 40° values.

The bacterial ratios for the different waters included in the 50° series are shown in Table No. 4. In general, the 20°–40° bacteria ratios and the ratios between the 20° bacteria and the 40° acid-producers were much greater for the sewage and the effluents from sewage filters than for the other waters, although there are a few exceptions to this rule. The 20°–40° ratios for the polluted river water in each case were much less than the corresponding ratios for Applied 216 and for the effluents from water Filters Nos. 8 and 216 and the city filter, indicating that the removal of the ordinary water bacteria by coagulation and sedimentation, and by filtration, is greater than is the removal of bacteria capable of developing at 40°, as previously noted in the discussion of the 30° series. The peculiar significance in the ratios between the bacteria and the acid-formers at 20° appears to be in the much larger ratios obtained for sewages and the effluents from sewage filters than for the other waters examined. This distinction does not hold true for the 40° and 50° bacteria-acid-producing-organism ratios, the high and low values being distributed among all classes of waters.

TABLE No. 3 — *Bacterial Ratios for Different Classes of Waters; 20°, 30° and 40° C. Series.*

| | Ratio between Total Bacteria at 20° and Bacteria developing at — | | Ratio between Total Bacteria at 20° and Number of Acid-producing Bacteria at — | | Ratio between Number of Bacteria at each Temperature and Acid-producing Bacteria at that Temperature. | | |
|---|---|---|---|---|---|---|---|
| | 30° C. | 40° C. | 30° C. | 40° C. | 20° C. | 30° C. | 40° C. |
| Canal, | 12.20 | 1.97 | 3.46 | 1.07 | 23 | 32 | 54 |
| Intake, | 12.38 | 2.44 | 3.46 | 0.84 | 13 | 28 | 34 |
| Applied 216, | 10.15 | 2.30 | 2.75 | 1.40 | 27 | 27 | 61 |
| Filter No. 216, | 4.45 | 3.89 | 1.67 | 2.78 | 15 | 38 | 71 |
| Filter No. 220, | 22.50 | 6.25 | 2.50 | 1.25 | 14 | 11 | 20 |
| City filter, | 8.70 | 17.40 | 4.35 | 8.70 | 26 | 50 | 50 |
| Pond No. 1, | 0.00 | 8.33 | 0.00 | 0.00 | 16 | 0 | 0 |
| Pond No. 2, | 5.90 | 5.90 | 0.00 | 5.90 | 6 | 0 | 100 |

TABLE No. 4.— *Bacterial Ratios for Different Classes of Waters 20°, 40° and 50°C. Series.*

| | RATIO BETWEEN TOTAL BACTERIA AT 20° AND BACTERIA DEVELOPING AT— | | RATIO BETWEEN TOTAL BACTERIA AT 20° AND NUMBER OF ACID-PRODUCING BACTERIA AT— | | RATIO BETWEEN NUMBER OF BACTERIA AT EACH TEMPERATURE AND ACID-PRODUCING BACTERIA AT THAT TEMPERATURE. | | |
|---|---|---|---|---|---|---|---|
| | 40° C. | 50° C. | 40° C. | 50° C. | 20° C. | 40° C. | 50° C. |
| Regular sewage, | 19.00 | 0.23 | 11.60 | 0.15 | 48 | 62 | 57 |
| Station sewage, | 21.50 | 1.80 | 16.90 | 1.49 | 62 | 79 | 84 |
| Septic sewage, | 26.00 | 0.08 | 18.50 | 0.05 | 50 | 71 | 59 |
| Sand Filter No. 1, | 83.80 | 1.22 | 72.80 | 0.61 | - | 87 | 50 |
| Sand Filter No. 2, | 11.40 | 0.00 | 5.70 | 0.00 | 83 | 50 | 00 |
| Sand Filter No. 4, | 10.00 | 0.08 | 9.20 | 0.00 | 27 | 92 | 00 |
| Sand Filter No. 9, | 25.30 | 0.30 | 23.00 | 0.00 | - | 91 | 00 |
| Trickling filters:— | | | | | | | |
| No. 135, | 11.20 | 0.95 | 8.80 | 0.65 | 98 | 78 | 65 |
| No. 136, | 8.70 | 0.23 | 5.10 | 0.09 | 69 | 58 | 37 |
| Contact filters:— | | | | | | | |
| No. 175, | 17.70 | 5.70 | 15.50 | 5.50 | 76 | 87 | 96 |
| No. 176, | 15.20 | 2.10 | 11.50 | 2.10 | 75 | 76 | 100 |
| No. 251, | 29.30 | 0.15 | 15.00 | 0.07 | 63 | 51 | 41 |
| Canal, | 0.68 | 0.08 | 0.53 | 0.01 | 41 | 78 | 40 |
| Intake, | 1.22 | 0.02 | 0.79 | 0.01 | 15 | 65 | 50 |
| Applied 216, | 7.56 | 0.07 | 2.36 | 0.04 | 59 | 31 | 50 |
| Filter No. 8, | 9.40 | 3.12 | 3.12 | 3.12 | 19 | 33 | 100 |
| Filter No. 216, | 23.80 | 0.28 | 14.10 | 0.14 | 86 | 59 | 50 |
| Filter No. 243, | 1.61 | 0.00 | 0.00 | 0.00 | 26 | 00 | 00 |
| City filter, | 14.70 | 0.67 | 11.35 | 0.67 | 9 | 77 | 100 |
| City water, | 7.80 | 1.56 | 4.70 | 1.56 | 17 | 60 | 100 |
| Pond No. 1, | 3.70 | 0.00 | 3.70 | 0.00 | 30 | 100 | 00 |
| Pond No. 2, | 11.25 | 0.00 | 7.40 | 0.00 | 42 | 63 | 00 |
| Driven wells, | 0.00 | 0.00 | 0.00 | 0.00 | 00 | 00 | 00 |
| Shallow Well No. 1, | 0.20 | 0.00 | 0.10 | 0.00 | 00 | 50 | 00 |
| Shallow Well No. 2, | 14.20 | 0.00 | 10.80 | 0.00 | 16 | 76 | 00 |
| Spring No. 1, | 0.00 | 0.00 | 0.00 | 0.00 | 12 | 00 | 00 |
| Spring No. 2, | 2.50 | 0.00 | 2.50 | 0.00 | 10 | 100 | 00 |

## BACTERIAL DETERMINATIONS AT 20° AND 40°C.

In addition to the results obtained in the 30° and 50° series previously discussed, we have somewhat more extended information regarding the relation between the numbers of bacteria developing at 20° and at 40°C. Comparative counts at the two temperatures are available on samples collected at least three times a week throughout the past two years from four different polluted sources; these being Merrimack River at the intake of the city filter, and from the north canal at the Experiment Station, river water which has been treated by coagulation and sedimentation, and river water in which the pollution has been increased by the addition of more sewage.

The averages of the determinations of bacteria at 20° and 40°C., and the corresponding bacterial ratios on samples of the intake, canal, Applied 216 and Applied 219, are shown in Table No. 5. Comparing the canal results with those from Applied 216, the yearly averages show us that treatment of the canal water by coagulation and sedimentation removed about one-half of the bacterial contents of the water. On the other hand,

the ratios show us that the removal of bacteria capable of growing at 40° and of B. coli was less than that of the total bacteria. Furthermore, while the monthly fluctuation in the numbers of total bacteria, of bacteria growing at 40° and of B. coli was less in the Applied 216 than in the canal, the fluctuation in the ratios between these numbers was much greater.

Comparing the canal with Applied 219, we find that by adding a small proportion of sewage to the water we have increased our bacterial content, as shown by higher values on all three determinations; but by comparing our ratios we find that we have increased the class of bacteria developing at 40°, in which must be included the disease germs, in a much larger proportion than we have increased the total bacterial content. The fluctuation in the numbers of the different classes of bacteria and the fluctuation in the ratios between these numbers correspond fairly well with the probable difference in the character of the two waters. In other words, our ratios indicate that both Applied 216 and Applied 219 were more dangerous from a sanitary standpoint than the difference between their total bacterial counts and the count on the canal water would indicate.

During 1906, in addition to the usual 20° counts, and qualitative tests for B. coli, counts of the bacteria and acid-formers at 40° have been made on a considerable proportion of samples of effluents from the experimental water filters at the station and from the Lawrence city filter, and the average results and the corresponding bacterial ratios are shown in Table No. 6. The ratio figures on these filtered waters are characteristically different from those for the unfiltered waters, the ratio between the 20° bacteria and 40° bacteria and that between the 20° bacteria and the B. coli for the filtered waters being many times greater than those for the raw waters. Comparing the ratios for the different filters we observe that the effluents from the secondary Filters Nos. 218 and 244 differ from those for the primary filter in that they contained a very much smaller proportion of B. coli. The similarity between the three sets of ratios for the city filter and Filter No. 8 is also noticeable, and in this case we are thoroughly justified in stating that the effluent from the city filter was the better, since it contained smaller numbers of bacteria. The ratios for Filters Nos. 280 and 286 are abnormal, agreeing with those for neither the primary nor the secondary filters. The disagreement in the ratios for Filter No. 286 can be accounted for by excessively high numbers of bacteria determined at 20°. The variation in the case of Filter No. 280 cannot be satisfactorily explained at this time, but it must be remembered that this filter was operated more as a strainer than as a slow sand or biological filter.

In Table No. 7 are shown the average results of determinations of numbers of bacteria at the two temperatures, and the corresponding bacterial ratios for sewages and the effluents from the various experimental sewage filters during 1906. A certain similarity will be noted between the bacterial ratios for the sewages and the effluents from the trickling and contact filters. The similarity between the effluents from Filters Nos. 2 and 4 and the effluents from the water filters in Table No. 6 is also noticeable, both as regards number of bacteria and bacterial ratios, while the effluents from the secondary filters appear to resemble the polluted waters shown in Table No. 5. The bacterial ratios from Filters Nos. 305, 306 and 312 to 316 inclusive are quite different from those for the other sand filters. As these filters have been operated only a few months it is probable that a condition of bacterial stability has not been reached, and for this reason the ratios may be abnormal.

TABLE NO. 5.—*Average Number of Bacteria at 20° and 40° C., and Bacterial Ratios for Polluted Waters, 1905 to 1906 inclusive.*

| | 20° C. Bacteria per Cubic Centimeter. | 40° C. | | 20°-40° C. Bacteria Ratio. | Bacteria 20°-B. Coli Ratio. | Bacteria 40°-B. Coli Ratio. |
|---|---|---|---|---|---|---|
| | | Bacteria per Cubic Centimeter. | B. Coli per Cubic Centimeter. | | | |
| **Intake:—** | | | | | | |
| Average, | 7,300 | 270 | 107 | 3.70 | 1.46 | 40 |
| Maximum, | 19,500 | 2,200 | 280 | 35.20 | 5.90 | 94 |
| Minimum, | 1,000 | 47 | 31 | 1.08 | 0.71 | 7 |
| **Canal:—** | | | | | | |
| Average, | 6,400 | 295 | 117 | 4.63 | 1.83 | 40 |
| Maximum, | 25,600 | 1,200 | 395 | 24.00 | 7.90 | 88 |
| Minimum, | 1,900 | 46 | 21 | 1.46 | 0.63 | 10 |
| **Applied 216:—** | | | | | | |
| Average, | 2,900 | 97 | 58 | 3.34 | 2.00 | 60 |
| Maximum, | 8,600 | 233 | 162 | 20.00 | 8.42 | 79 |
| Minimum, | 950 | 25 | 12 | 0.96 | 0.59 | 41 |
| **Applied 219:—** | | | | | | |
| Average, | 27,400 | 2,500 | 2,000 | 9.20 | 7.28 | 79 |
| Maximum, | 61,200 | 9,500 | 8,500 | 25.74 | 18.52 | 97 |
| Minimum, | 8,400 | 260 | 198 | 1.38 | 0.80 | 36 |

TABLE NO. 6.—*Average Number of Bacteria at 20° and 40°C, and Bacterial Ratios for Effluents from Water Filters.*

| | 20° C. Bacteria per Cubic Centimeter. | 40° C. | | 20°-40° C. Bacteria Ratio. | Bacteria 20°-B. Coli Ratio. | Bacteria 40°-B. Coli Ratio. |
|---|---|---|---|---|---|---|
| | | Bacteria per Cubic Centimeter. | B. Coli per Cubic Centimeter. | | | |
| Filter No. 8, | 115 | 19 | 11 | 16.5 | 9.6 | 58 |
| Filter No 218,[1] | 13 | 13 | 1 | 86.6 | 6.7 | 8 |
| Filter No. 219, | 159 | 66 | 38 | 41.5 | 23.9 | 58 |
| Filter No. 220, | 43 | 13 | 7 | 30.2 | 16.3 | 54 |
| Filter No. 244,[1] | 15 | 8 | 1 | 53.4 | 6.7 | 13 |
| Filter No. 280, | 190 | 100 | 10 | 52.6 | 5.3 | 10 |
| Filter No. 281,[1] | 58 | 17 | 10 | 29.3 | 17.3 | 59 |
| Filter No. 286,[1] | 1,240 | 46 | 20 | 3.7 | 1.6 | 44 |
| City filter, | 34 | 5 | 3 | 14.7 | 8.8 | 60 |

[1] Secondary filters.

TABLE NO. 7.—*Average Number of Bacteria at 20° and 40° C., and Bacterial Ratios for Sewages and Effluents from Sewage Filters.*

| | 20° C. Bacteria per Cubic Centimeter. | 40° C. Bacteria per Cubic Centimeter. | 40° C. B. Coli per Cubic Centimeter. | 20°–40° C. Bacteria Ratio. | Bacteria 20°–B. Coli Ratio. | Bacteria 40°–B. Coli Ratio. |
|---|---|---|---|---|---|---|
| Regular sewage, | 1,031,000 | 333,500 | 285,500 | 32.4 | 27.8 | 86 |
| Lawrence Street sewage. | 1,144,700 | 468,800 | 440,100 | 40.8 | 38.4 | 94 |
| Andover sewage, | 629,000 | 181,600 | 135,100 | 28.9 | 21.5 | 74 |
| Concentrated sewage, | 1,546,200 | 558,500 | 505,400 | 36.0 | 32.6 | 91 |
| Settled sewage, | 757,000 | 220,600 | 196,400 | 29.4 | 25.9 | 89 |
| Strained sewage, | 394,400 | 164,200 | 136,300 | 41.6 | 34.5 | 83 |
| Septic sewage A, | 537,100 | 207,900 | 168,600 | 38.7 | 31.5 | 81 |
| Septic sewage F, | 302,500 | 115,300 | 110,900 | 37.9 | 36.6 | 97 |
| Sand Filter No. 1, | 4,800 | 2,500 | 2,400 | 52.1 | 50.0 | 96 |
| Sand Filter No 2, | 93 | 9 | 6 | 9.7 | 6.5 | 67 |
| Sand Filter No. 4, | 81 | 9 | 7 | 11.1 | 8.6 | 78 |
| Sand Filter No. 5C, | 1,100 | 124 | 112 | 11.3 | 10.2 | 90 |
| Sand Filter No. 6, | 5,600 | 2,800 | 2,500 | 50.0 | 44.6 | 89 |
| Sand Filter No. 9A, | 1,900 | 720 | 555 | 37.8 | 29.2 | 77 |
| Sand Filter No. 10, | 480 | 110 | 81 | 22.9 | 16.8 | 74 |
| Sand Filter No. 100, | 26,600 | 10,800 | 7,700 | 40.6 | 28.9 | 71 |
| Sand Filter No. 242, | 124 | 37 | 34 | 29.8 | 27.4 | 92 |
| Sand Filter No. 305, | 1,210 | 29 | 15 | 2.4 | 1.2 | 52 |
| Sand Filter No. 306, | 1,305 | 16 | 7 | 1.2 | 0.5 | 44 |
| Sand Filter No. 312, | 620 | 10 | 10 | 1.6 | 1.6 | 100 |
| Sand Filter No. 313, | 1,480 | 220 | 185 | 14.9 | 12.5 | 84 |
| Sand Filter No. 314, | 2,120 | 143 | 28 | 6.8 | 1.3 | 20 |
| Sand Filter No. 315, | 1,490 | 11 | 0 | 0.7 | 0.0 | 0 |
| Sand Filter No. 316, | 740 | 21 | 0 | 2.8 | 0.0 | 0 |
| Contact Filter No. 175, | 347,500 | 156,400 | 124,600 | 44.8 | 35.9 | 80 |
| Contact Filter No. 176, | 214,400 | 92,500 | 82,900 | 43.0 | 38.6 | 90 |
| Contact Filter No. 221, | 438,000 | 145,700 | 109,400 | 33.3 | 24.9 | 75 |
| Contact Filter No. 237, | 358,000 | 112,000 | 95,000 | 31.3 | 26.5 | 85 |
| Contact Filter No. 251, | 456,000 | 170,000 | 159,000 | 37.2 | 34.9 | 94 |
| Trickling filters:— | | | | | | |
| No. 135, | 32,100 | 14,100 | 12,400 | 43.8 | 38.6 | 88 |
| No. 136, | 23,500 | 8,400 | 7,600 | 35.7 | 32.3 | 91 |
| No. 222, | 119,500 | 36,100 | 35,000 | 30.1 | 29.2 | 97 |
| No. 233, | 186,000 | 60,000 | 47,000 | 32.2 | 25.2 | 78 |
| No. 235, | 148,000 | 50,000 | 36,500 | 33.8 | 24.6 | 73 |
| No. 247, | 195,000 | 61,700 | 40,100 | 31.6 | 20.6 | 65 |
| No. 248, | 39,900 | 16,200 | 12,400 | 40.6 | 31.0 | 77 |
| Secondary filters:— | | | | | | |
| No. 224, | 2,400 | 200 | 130 | 8.3 | 5.4 | 65 |
| No. 249, | 25,300 | 6,500 | 1,570 | 25.6 | 6.2 | 24 |
| No. 250, | 20,100 | 1,470 | 760 | 7.3 | 3.8 | 52 |

## RELATION BETWEEN BACTERIA AND B. COLI IN THE MERRIMACK RIVER WATER.

Routine determinations of bacteria and B. coli have been made on samples of Merrimack River water from the intake during a period of eight years, and on samples from the canal during a period of nine years, and the average monthly analyses of samples from these two sources have been published annually. The ratios between the bacteria and B. coli, computed from the monthly averages for these two sources, are shown in tables Nos. 8 and 9. The use of monthly averages tends to eliminate abnormal values and fluctuations, and to give us results which

are nearly normal, and the fluctuations occurring from month to month must be considered normal fluctuations.

The numbers of bacteria and of B. coli in the intake have usually been somewhat greater than those in the canal. A study of the ratios between the total bacteria and the B. coli reveals that those ratios also have been constantly higher for the intake than for the canal, and that there has been a greater uniformity in the bacterial content of the Merrimack River water after it has passed through the canal and the distribution pipes to the experimental filters at the Experiment Station, taking the results year by year, and month by month, than was the case with the same water as it was applied to the Lawrence city filter. In the canal water the greatest proportion of B. coli were usually found in samples collected in July and August, and the smallest proportion in samples collected during March or October, although no such general rule can be stated with regard to samples collected at the intake of the city filter.

The average ratio on all samples collected from the intake during the entire eight years was 1.52, the lowest yearly average being 0.81, in 1899, and the highest, 2.77, in 1900. The lowest monthly average occurred in August, 1899, and again in December, 1901, when the ratio was 0.16, and the highest monthly average, 6.30, occurred in March, 1900. The least variation in the monthly ratios for any one year occurred in 1904, the difference between the highest and lowest values in that year being 1.27. The greatest variation in the monthly ratios in any year occurred in 1900, when the difference between the highest and lowest ratios was 6.08.

The average ratio on all samples from the canal during the entire period of nine years was 1.16, the lowest yearly average being 0.80, in 1899, and the highest, 3.18, in 1906. The lowest monthly ratio occurred in October, 1901, when the ratio was 0.08, and the highest occurred in August, 1906, when the ratio was 7.90. The least variation in the monthly ratios during any one year occurred in 1903, the difference between the highest and lowest values being 1.01, and the greatest variation in the monthly ratios occurred in 1906, the difference between the highest and lowest values being 7.03.

TABLE No. 8. — *Average Monthly Bacteria-B. Coli Ratios on Samples from the Merrimack River at the Intake of the City Filter, 1899 to 1906, inclusive.*

| | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | Average. |
|---|---|---|---|---|---|---|---|---|---|
| January, | 0.57 | 0.69 | 1.64 | 0.29 | 0.26 | 0.61 | 0.71 | 1.22 | 0.75 |
| February, | 0.53 | 0.47 | 3.28 | 0.61 | 0.33 | 0.71 | 0.84 | 1.25 | 1.00 |
| March, | 0.30 | 6.30 | 0.78 | 0.44 | 0.98 | 0.57 | 0.95 | 1.05 | 1.42 |
| April, | 0.41 | 1.30 | 2.43 | 0.88 | 1.09 | 0.44 | 1.06 | 0.97 | 1.01 |
| May, | 1.10 | 1.56 | 1.43 | 0.85 | 1.41 | 1.71 | 1.37 | 3.19 | 1.58 |
| June, | 1.57 | 1.48 | 0.73 | 2.40 | 0.78 | 1.25 | 0.91 | 5.90 | 1.88 |
| July, | 1.97 | 1.51 | 0.61 | 0.43 | 1.78 | 1.56 | 1.46 | 2.31 | 1.45 |
| August, | 0.16 | 1.31 | 1.06 | 1.05 | 1.65 | 0.97 | 1.39 | 5.88 | 1.68 |
| September, | 0.83 | 0.93 | 0.50 | 1.07 | 0.87 | 0.66 | 1.40 | 2.34 | 1.01 |
| October, | 0.24 | 0.22 | 0.53 | 0.58 | 0.44 | 1.66 | 1.10 | 1.63 | 0.79 |
| November, | 0.61 | 1.86 | 4.07 | 1.92 | 1.32 | 0.70 | 1.84 | 2.32 | 1.83 |
| December, | 1.43 | 1.98 | 0.16 | 1.03 | 0.66 | 0.64 | 1.06 | 5.28 | 1.52 |
| Average, | 0.81 | 1.63 | 1.44 | 0.92 | 0.92 | 0.96 | 1.17 | 2.77 | 1.33 |
| Maximum, | 1.97 | 6.30 | 4.07 | 2.40 | 1.78 | 1.71 | 1.84 | 5.90 | 6.30 |
| Minimum, | 0.16 | 0.22 | 0.16 | 0.29 | 0.26 | 0.44 | 0.71 | 0.97 | 0.16 |

TABLE No. 9. — *Average Monthly Bacteria-B. Coli Ratios on Samples from the Merrimack River from the North Canal, 1898-1906, inclusive.*

| | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | Average. |
|---|---|---|---|---|---|---|---|---|---|---|
| January, | 0.80 | 0.83 | 0.47 | 2.56 | 0.52 | 0.39 | 0.95 | 1.21 | 1:51 | 1.03 |
| February, | 0.59 | 0.45 | 0.60 | 2.42 | 0.61 | 0.44 | 1.22 | 1.00 | 1.55 | 0.99 |
| March, | 0.45 | 0.29 | 0.61 | 1.41 | 0.14 | 0.61 | 0.37 | 1.11 | 1.67 | 0.74 |
| April, | 1.20 | 0.65 | 0.70 | 1.10 | 1.86 | 1.06 | 0.50 | 1.43 | 0.87 | 1.04 |
| May, | 0.79 | 0.82 | 0.98 | 0.83 | 1.37 | 0.95 | 0.81 | 1.54 | 1.83 | 1.10 |
| June, | 0.56 | 0.97 | 1.96 | 0.44 | 0.60 | 0.65 | 0.93 | 0.94 | 1.33 | 0.93 |
| July, | 1.12 | 2.50 | 2.59 | 0.47 | 0.43 | 0.90 | 2.32 | 2.26 | 5.08 | 1.96 |
| August, | 2.12 | 0.78 | 1.08 | 0.16 | 1.94 | 0.87 | 1.86 | 2.66 | 7.90 | 2.15 |
| September, | 1.75 | 0.41 | 0.71 | 1.82 | 0.97 | 0.57 | 0.88 | 1.09 | - | 0.96 |
| October, | 0.55 | 0.11 | 0.46 | 0.08 | 0.91 | 0.70 | 1.00 | 0.63 | - | 0.56 |
| November, | 1.07 | 0.62 | 1.24 | 0.27 | 0.98 | 1.40 | 0.86 | 1.45 | - | 0.99 |
| December, | 0.65 | 0.93 | 1.53 | 0.81 | 0.66 | 0.49 | 0.38 | 1.54 | 6.91 | 1.49 |
| Average, | 0.97 | 0.80 | 1.08 | 0.95 | 0.92 | 0.75 | 1.01 | 1.41 | 3.18 | 1.16 |
| Maximum, | 2.12 | 2.50 | 2.59 | 2.56 | 1.94 | 1.40 | 2.32 | 2.66 | 7.90 | 7.90 |
| Minimum, | 0.45 | 0.11 | 0.46 | 0.08 | 0.14 | 0.39 | 0.37 | 0.63 | 0.87 | 0.08 |

## Influence of Temperature, Oxygen and Dilution upon the Bacterial Contents of the Merrimack River Water.

The volume of water flowing in the river, the temperature of the water and the amount of dissolved oxygen are the fluctuating factors which are most likely to influence the numbers of bacteria and B. coli in the water from such a source as the Merrimack River. It is quite generally understood that the amount of oxygen dissolved in water varies inversely as the temperature, a greater amount of oxygen being present in the winter, when the water is cold, than in the summer, when the water is warm. A study of the temperatures of the water, and of the amounts of dissolved oxygen at times of high and low water, reveals the fact that the average temperature was high, and the average amount of dissolved oxygen was low, when the river was low, these factors decreasing and increasing, respectively, as the volume of flow in the river increased. In Table No. 10 the bacterial contents of the river samples during the past eight years have been averaged according to the amount of dissolved oxygen in the water at the time they were collected. The numbers of bacteria and of B. coli were both at a maximum when the dissolved oxygen in the water was between 0.50 and 0.75 parts per 100,000. As the amount of oxygen increased or decreased from these limits, the numbers of bacteria and B. coli decreased, but the numbers of B. coli decreased much more rapidly with the increase in dissolved oxygen than did the other bacteria. This is shown by the bacteria–B. coli ratios in the last column of the table, the ratios decreasing in proportion as the amount of oxygen in the water increased.

TABLE No. 10.—*Relation between Amount of Dissolved Oxygen and the Bacterial Contents of Merrimack River Water.*

| Dissolved Oxygen (Parts per 100,000). | Bacteria per Cubic Centimeter. | B. Coli per Cubic Centimeter. | Bacteria-B. Coli Ratio. |
|---|---|---|---|
| Less than 0.50, | 6,200 | 74 | 1.42 |
| Between 0.50 and 0.75, | 10,000 | 104 | 1.16 |
| Between 0.75 and 1.00, | 6,000 | 47 | 0.87 |
| Between 1.00 and 1.25, | 4,200 | 37 | 0.88 |
| More than 1.25, | 5,200 | 30 | 0.59 |

It has previously (1902, report Massachusetts Board of Health, page 250) been shown that the average numbers of B. coli in the Merrimack River water are higher during the summer than during the winter. A similar variation can be noted in Table No. 11, in which the bacteria and

B. coli and the ratio between the two for samples from the intake and the canal during the past eight years have been arranged according to the temperature of the water at the time the samples were collected. The maximum numbers of both bacteria and B. coli occurred in samples from both locations when the temperature of the water was between 60° and 70°F., and the minimum numbers of bacteria were found when the temperature was between 40° and 50°F. The temperature at which the minimum numbers of B. coli were found in samples from the two locations do not agree, being lowest in the canal water when the temperature was between 40° and 50°F., and lowest in the intake samples when the temperature was between 30° and 40°F. The bacteria–B. coli ratios were highest when the temperature was highest and lowest when the temperature was lowest, although the values for intermediate temperatures appear to follow no definite curve.

TABLE NO. 11.—*Relation between Temperature and Bacterial Contents of Merrimack River Water.*

| Temperature of Water (Degrees F.). | Bacteria per Cubic Centimeter. | | B. Coli per Cubic Centimeter. | | Bacteria–B. Coli Ratio. | |
|---|---|---|---|---|---|---|
| | Canal. | Intake. | Canal. | Intake. | Canal. | Intake. |
| Below 40°, | 5,800 | 8,800 | 48 | 56 | 0.88 | 0.72 |
| Between 40° and 50°, | 4,000 | 4,500 | 36 | 58 | 0.91 | 1.10 |
| Between 50° and 60°, | 6,400 | 9,500 | 44 | 58 | 0.88 | 0.99 |
| Between 60° and 70°, | 11,300 | 15,300 | 100 | 110 | 1.08 | 0.97 |
| Above 70°, | 5,200 | 6,700 | 70 | 82 | 1.39 | 1.21 |

The averages of bacteria determinations and the bacteria–B. coli ratios, arranged according to the volume of water flowing in the river, are shown in Table No. 12. Both bacteria and B. coli decreased as the volume of the river increased. We should expect this to be the case in a river such as the Merrimack, in which a large proportion of bacteria and B. coli are contributed by the sewage entering that river, the effect of dilution overbalancing other factors, such as washings from cultivated fields, etc., when averages of a large number of samples extending over a considerable period are included. The ratios between the bacteria and B. coli on samples from the two sources do not agree, the highest ratios being obtained for the canal samples when the river was low, and the lowest ratios when the river was high. With the intake samples, however, the lowest ratios occurred at a time of medium high water, and the highest at extreme high water.

TABLE No. 12. — *Relation between Volume of Flow and the Bacterial Contents of Merrimack River Water.*

| Flow of River (Cubic Feet per Second per Square Mile of Watershed). | Bacteria per Cubic Centimeter. | | B. Coli per Cubic Centimeter.* | | Bacteria-B. Coli Ratio. | |
|---|---|---|---|---|---|---|
| | Canal. | Intake. | Canal. | Intake. | Canal. | Intake. |
| Less than 1, | 7,500 | 10,800 | 66 | 88 | 1.07 | 0.97 |
| Between 1 and 2, | 6,800 | 6,200 | 50 | 51 | 0.73 | 0.99 |
| Between 2 and 4, | 3,600 | 5,600 | 29 | 39 | 0.83 | 0.56 |
| Above 4, | 3,400 | 3,100 | 16 | 29 | 0.63 | 1.07 |

THE EFFICIENCY OF WATER FILTERS AS SHOWN BY COUNTS AT DIFFERENT TEMPERATURES.

It has already been demonstrated that the various bacterial ratios are in many cases quite different for a given water before and after filtration, and that probably the filter removes a greater proportion of certain types of bacteria than it does of other types. In Table No. 13 are shown the bacterial removal by a number of water filters as estimated from counts at different temperatures, the bacterial counts from which these results have been computed being given in tables Nos. 1, 2 and 6, for samples designated Series I., II. and III., respectively. From the figures in the table we observe that there is a certain similarity between the filter efficiencies obtained from counts at 20° and 30°C., but that the removal of the types of bacteria developing at 40° and 50° was much less than of the other forms. The efficiencies for Filter No. 286 illustrate the value of counts at 40°C., the 20° count showing no bacterial removal, while the 40°C. count shows a removal of between 40 and 50 per cent. of the bacteria. This condition of affairs was undoubtedly caused by growth of harmless types of bacteria in the filter or in the connecting pipes between the primary and secondary filter, with the result that our double filtration system is actually doing better work than the counts at 20° would indicate. So far as we know, the types of bacteria growing at 40°C. do not multiply in water under ordinary conditions, while growths of ordinary water bacteria are more or less common.

TABLE No. 13.— *Showing Bacterial Efficiency of Water Filters as computed from Counts at Different Temperatures.*

| | Series. | PERCENTAGE REMOVAL OF BACTERIA COMPUTED FROM COUNTS OF — | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOTAL BACTERIA AT — | | | | ACID-PRODUCING BACTERIA AT — | | | |
| | | 20°. | 30°. | 40°. | 50°. | 20°. | 30°. | 40°. | 50°. |
| City filter, . . . | I. | 99.5 | 99.7 | 96.7 | - | 99.1 | 99.4 | 95.2 | - |
| Filter No. 220, . . | I. | 98.1 | 96.0 | 93.8 | - | 98.8 | 98.6 | 97.7 | - |
| Filter No. 216, . . | I. | 91.0 | 96.1 | 82.9 | - | 95.0 | 94.6 | 82.2 | - |
| Filter No. 8, . . . | II. | 99.8 | - | 97.3 | 80.0 | 99.1 | - | 96.9 | 50.0 |
| City filter, . . . | II. | 99.1 | - | 89.4 | 75.0 | 99.4 | - | 87.3 | 50.0 |
| Filter No. 216, . . | II. | 74.4 | - | 20.0 | 0.0 | 84.3 | - | 0.0 | 0.0 |
| Filter No. 243, . . | II. | 91.3 | - | 99.4 | 100.0 | 96.8 | - | 100.0 | 100.0 |
| Filter No. 8, . . . | III. | 97.8 | - | 98.4 | - | - | - | 97.3 | - |
| Filter No. 218, . . | III. | 55.7 | - | 0.0 | - | - | - | 50.0 | - |
| Filter No. 219, . . | III. | 98.9 | - | 96.5 | - | - | - | 95.3 | - |
| Filter No. 220, . . | III. | 99.0 | - | 99.1 | - | - | - | 98.8 | - |
| Filter No. 244, . . | III. | 50.0 | - | 42.9 | - | - | - | 83.4 | - |
| Filter No. 230, . . | III. | 95.6 | - | 84.0 | - | - | - | 95.5 | - |
| Filter No. 231, . . | III. | 69.5 | - | 83.0 | - | - | - | 0.0 | - |
| Filter No. 236, . . | III. | 0.0 | - | 40.3 | - | - | - | 47.4 | - |
| City Filter, . . . | III. | 99.1 | - | 98.0 | - | - | - | 97.1 | - |

## RELATION BETWEEN PLATE TESTS FOR ACID-PRODUCERS AND FERMENTATION TESTS FOR B. COLI.

In many places in this report, and in the annual reports of the experiments on water filtration, the number of bacteria producing acid fermentation of lactose in eighteen hours at 40°C. have been recorded as the number of B. coli, although strictly speaking only about 80 to 90 per cent. of such colonies are of the true colon type. Hitherto, the plate method has been applied only to waters containing relatively large numbers of B. coli, the purer waters being tested by the fermentation method. With the application of the plate method to filtered waters of low bacterial content, upon which B. coli tests are ordinarily made by the fermentation method, we are confronted with the problem of the relative significance of the results obtained by the two methods. In Table No. 14 are shown the proportion of samples from the various water filters which contained acid-producing bacteria according to the plate method, which contained organisms fermenting dextrose and in which B. coli were

actually proved to be present by complete confirmatory tests. The bacterial counts and ratios for these samples have already been given in Table No. 6. In all, about 450 samples of filtered waters are included in the computations, of which 76 per cent. contained bacteria of the acid-producing type, 46 and 99 per cent. contained bacteria producing gas in dextrose in 1 and 100 cubic centimeters, respectively, and 24 and 62 per cent. contained B. coli, respectively, in 1 and 100 cubic centimeters. In general, the proportion of samples containing acid-producers is intermediate between the per cent. of fermentation tests in 1 and 100 cubic centimeters, and approximates more or less closely the occurrence of B. coli in 100 cubic centimeters.

A study of the individual results, from which the totals in the table were taken, enables us to determine the approximate accuracy of the presence of acid-producers as an index of the presence or absence of fermenting bacteria and of B. coli. Among those samples containing acid-producing bacteria a correct impression of the presence of fermenting types would have been obtained in 1 and 100 cubic centimeters in 52 per cent. and 99 per cent., respectively, and the presence of B. coli would have been correctly indicated in 1 and 100 cubic centimeters, respectively, in 29 and 67 per cent. of the samples. On the other hand, positive fermentations occurred in 1 and 100 cubic centimeters in 39 and 96 per cent., respectively, of samples in which acid-producing bacteria were absent, and B. coli were found in 15 per cent. and 57 per cent. of the 1 and 100 cubic centimeter tests made on samples of the same group. In other words, the presence or absence of fermenting organisms was correctly indicated by the appearance of red colonies on the lactose-agar plates at 40°C., for 54 per cent. of the 1 cubic centimeter tests, and for 75 per cent. of the 100 cubic centimeter tests, while the indication of the presence of B. coli was correct for 42 per cent. and 67 per cent. of the 1 and 100 cubic centimeter tests, respectively.

The plate methods covered bacteria of the sewage streptococcus type which are not shown by the fermentation tests, and it is probable that the results obtained by its use will be fully as significant as the results of the fermentation tests and B. coli determinations when once the interpretation of the presence and numbers of acid-producers is more fully understood, its chief advantage being that results may be obtained within twenty-four hours, while at least two weeks are required for a complete colon test.

TABLE No. 14.—*Relative Occurrence of Acid-Producers, Positive Fermentations and B. Coli in Effluents from Water Filters.*

| | Per Cent. of Samples. | | | | |
|---|---|---|---|---|---|
| | Containing Acid-Producers at 40° C. | Fermenting Dextrose. | | Containing B. coli. | |
| | | 1 c.c. | 100 c.c. | 1 c.c. | 100 c.c. |
| Filter No. 8, | 77 | 87 | 100 | 26 | 74 |
| Filter No. 218, | 7 | 7 | 71 | 0 | 36 |
| Filter No. 219, | 87 | 68 | 100 | 57 | 78 |
| Filter No. 220, | 67 | 58 | 100 | 33 | 88 |
| Filter No. 244, | 67 | 67 | 100 | 50 | 88 |
| Filter No. 280, | 88 | 58 | 100 | 36 | 70 |
| Filter No. 281, | 83 | 33 | 97 | 11 | 55 |
| Filter No. 286, | 98 | 42 | 100 | 23 | 72 |
| City filter, | 62 | 52 | 100 | 8 | 41 |
| Total, | 76 | 46 | 99 | 24 | 62 |

## Incubation Tests.

Some experiments made during 1906 tend to throw some light on the relation between the character of a water and its bacterial content. These tests were similar to the incubation or putrescibility tests quite commonly applied to effluents of filters of coarse materials, in which the samples are allowed to stand for a definite period, either in the laboratory or at a somewhat higher temperature, and determinations made to detect any change in the chemical constituents. In the bacterial incubation tests, samples were allowed to stand for twenty-four hours at 40°C., and determinations were made of the numbers of bacteria and of acid-producers before and after incubation. The test was applied to 10 samples from each of nineteen sources, and the results are shown in Table No. 15.

The polluted river water showed a large increase in numbers on nearly all samples after incubation, while the same water, after being treated with sulphate of alumina before being applied to Filter No. 216, either showed no material change, or a slight reduction in its bacterial content. The averages show an enormous increase in the total bacterial content of the filtered waters, as determined by both 20° and 40° counts, but only a slight change in the numbers of B. coli. A few individual samples showed a decrease in total bacteria, and only a slight change occurred in about half of the samples. In over 90 per cent. of the filtered water samples no change occurred in the numbers of B. coli.

Very little change in the bacterial contents of any of the sewages was noted during the incubation tests, a larger proportion of the septic sewage samples showing a slight increase than was the case with the raw sewages. The majority of samples from intermittent sand filters operated with sewage showed a decided diminution in bacteria. The majority of samples from both contact and trickling filters showed a slight increase in both bacteria and B. coli, but a greater proportion of the samples from trickling filters increased than was the case with the contact filter effluents.

TABLE No. 15. — *Numbers of Bacteria and B. Coli in Sewages and Waters before and after Incubation at 40° C.*

| | INITIAL NUMBER PER CUBIC CENTIMETER. | | | PER CENT. WHICH NUMBER AFTER INCUBATION WERE OF INITIAL NUMBER. | | |
|---|---|---|---|---|---|---|
| | Bacteria 20°. | Bacteria 40°. | B. Coli. | Bacteria 20°. | Bacteria 40°. | B. Coli. |
| Canal, | 2,400 | 70 | 44 | 7,700 | 146,000 | 42,000 |
| Intake, | 4,900 | 90 | 60 | 4,300 | 77,500 | 17,700 |
| Applied 216, | 1,650 | 28 | 13 | 249 | 12,100 | 69 |
| City filter, | 27 | 6 | 2 | 9,600 | 4,400 | 200 |
| City water, | 30 | 6 | 2 | 400 | 500 | 109 |
| Filter No. 8, | 55 | 12 | 5 | 370,000 | 6,800 | 160 |
| Filter No. 216, | 220 | 6 | 2 | 2,100 | 40,000 | 50 |
| Regular sewage, | 974,000 | 173,000 | 131,600 | 90 | 155 | 189 |
| Station sewage, | 756,000 | 92,300 | 70,200 | 205 | 340 | 300 |
| Andover sewage, | 615,700 | 175,700 | 112,100 | 158 | 680 | 470 |
| Septic sewage, | 412,000 | 84,300 | 55,600 | 500 | 330 | 215 |
| Filter No. 1, | 7,200 | 900 | 820 | 3 | 13 | 6 |
| Filter No. 9, | 700 | 80 | 65 | 28 | 26 | 12 |
| Filter No. 135, | 20,400 | 2,400 | 1,700 | 4,500 | 5,800 | 1,870 |
| Filter No. 136, | 51,100 | 5,700 | 5,300 | 5,300 | 7,200 | 915 |
| Filter No. 222, | 182,900 | 28,400 | 27,000 | 760 | 1,100 | 177 |
| Filter No. 175, | 280,500 | 27,800 | 26,700 | 500 | 183 | 164 |
| Filter No. 176, | 264,500 | 50,300 | 24,900 | 610 | 238 | 240 |
| Filter No. 251, | 206,700 | 14,600 | 13,100 | 1,390 | 980 | 910 |

## CONCLUSIONS.

Modern methods of bacterial examination of water, consisting usually of determinations of the numbers of bacteria by means of plates incubated at room temperature, and of tests for the presence or absence of one or two specific types, occasionally lead to an erroneous interpretation of the quality of a water, owing to the fact that they do not yield

adequate data by which abnormal and inaccurate results may be separated from those which are truly indicative of purity or pollution. Furthermore, as several days must elapse before the bacterial tests can be completed, the results when obtained may have passed their usefulness. If, however, we can so modify our procedure that the varied character of the bacteria in waters of different classes may be quickly and accurately recognized, the value of bacterial water analysis will be enormously increased. Much of this information may be obtained by the use of selective media, selective temperatures or by a proper combination of the two.

By the use of litmus-lactose-agar in place of agar or gelatin we obtain similar counts of total bacteria, and in addition are able to separate those bacteria into two groups, which do and do not produce acid fermentation of lactose, and the numbers of the two classes of bacteria so obtained indicate more completely the character of the water than would the numbers of either class alone. By incubating our plates at temperatures of 30° or 40° C. we are able to obtain counts in twelve to eighteen hours, which counts, while smaller than those on plates incubated for a longer period at a lower temperature, appear to be fully as significant. If we increase our number of determinations by incubating duplicate plates at two or more temperatures, the various results and the ratios between them furnish a check upon one another, in addition to increasing the available data upon which to base an interpretation.

The distinction between polluted waters and waters of good quality is more sharply marked by counts at 30° C. than is the case with counts at 20° C. Determinations at this temperature appear to be especially applicable to the control of water filters, since the relative quality of the raw and filtered waters and the expression of the removal of bacteria by those filters are practically identical with determinations made at 20° C., and, in addition, they become available within a few hours after the sample is collected.

The numbers of bacteria determined at 40° C. are of great value, since in this class of bacteria must be included the bacillus of typhoid fever and other water-borne diseases. The significance of the acid-producing bacteria determined at this temperature, that is to say, bacteria of the colon type, is well known. The evidence contained in this report will indicate that considerable numbers of bacteria of the colon type may occur in waters which are supposedly of good quality judging from its total bacterial content, while on other occasions positive tests for B. coli may be caused by isolated organisms of that type. In such cases no distinction could be made between the relatively good and the suspicious samples either by the numbers of bacteria or by the qualitative colon

tests, but the necessary information would be obtained by counts at 40°C. Determinations of B. coli by the plate method in the effluents of water filters agree with determinations by the fermentation test in about half of the samples, the isolation of B. coli being prevented quite frequently in this class of samples by the presence of the sewage streptococcus type, which would be included in the colon type under the plate method.

The results of determinations of the bacteria developing at 50°C. are too few in number to enable us to draw any definite conclusions as to their value. Bacteria of this type appear to be quite common in sewages and in the effluents from contact and trickling filters, while they are present only in small numbers in the effluents from sand filters and water filters, and are entirely absent from well and pond waters of good quality.

Determinations of bacteria and B. coli on the Merrimack River water extending over a period of some nine years enable us to study the bacteria–B. coli ratios and to ascertain with some accuracy the cause of fluctuations. In general, it may be stated that the proportion of B. coli in the river water is greater when the water is warm than when it is cold, and that the effect of heavy rains or melting snow, causing floods in the river, is to produce a diminution both in the numbers and in the proportion of B. coli. The effect of the amount of oxygen in the water is also noticeable, both bacteria and B. coli being at a maximum when the water contained between 0.50 and 0.75 parts of dissolved oxygen, decreasing as the oxygen value varied above or below that amount, the B. coli decreasing much more rapidly in either case than did the total number of bacteria.

# FOOD AND DRUG INSPECTION.

# FOOD AND DRUG INSPECTION.

In the annual report of the Board for 1905 was presented an historical account of the development of the work of inspection of food and drugs, and of the laws relating thereto, since the passage, in 1882, of the general law. During the year 1906 no change was made in the law, beyond the restoration of the maximum fine of $500; but on account of the enactment of the new law relating to proprietary medicines (chapter 386 of the Acts of 1906), referred to in the general report, and of additional demands on the laboratory for special lines of work, it was found necessary to increase the laboratory force by the appointment of an additional assistant analyst.

The report of the chief analyst presents a detailed account of the work of the food and drug laboratory for the fourteen months ended Nov. 30, 1906.

The force employed by the Board in this department at the close of the period covered by this report comprised the following persons: —

| | |
|---|---|
| Albert E. Leach, | *Analyst.* |
| Hermann C. Lythgoe, | *Assistant Analyst.* |
| Charles H. Hickey, | *Second Assistant Analyst.* |
| Lewis I. Nurenberg, | *Third Assistant Analyst.* |
| John H. Terry, | *Inspector.* |
| Horace F. Davis, | *Inspector.* |
| Daniel E. McCarthy, | *Inspector.* |

Chapter 272 of the Acts of 1902 requires the Board to publish as often "as once each month in the official publication of the Board . . . a certificate of the examination or analysis made by authority of the board during the preceding month of any article of food manufactured or offered for sale in the Commonwealth, which is adulterated within the meaning of chapter seventy-five of the Revised Laws; and the board shall also cause to be published, with such certificate of examination, a statement of the trade-mark, brand-mark, or name, with the name and place of business of the manufacturer, which appear upon the package or box containing such adulterated article, or with the name and place of business of the wholesale dealer of whom the goods were obtained."

The official publication referred to, the "Weekly Bulletin," published continuously for some twenty years and distributed principally to the health authorities of cities and towns, was changed in January, 1906, to a "Monthly Bulletin," which is sent regularly to all persons in the Commonwealth desirous of receiving it, and which at the close of the year had attained a circulation of more than 2,000 copies.

The number of samples of food and drugs examined during the fourteen months ended Nov. 30, 1906, is shown in the following table, together with a summary of the work done since the beginning in 1882: —

*Food and Drug Inspection (1882–1906).*

| Summary. | Years. | |
|---|---|---|
| | 1906. | Total 1882–1906. |
| Number of samples of milk examined, | 3,603 | 94,071 |
| Number of samples above standard, | 2,316 | 59,750 |
| Number of samples below standard, | 1,287 | 34,321 |
| Number of samples of other kinds of food examined (not milk), | 2,704 | 59,689 |
| Number of samples of good quality, | 2,214 | 48,717 |
| Number of samples adulterated, as defined by the statutes, | 490 | 10,972 |
| Number of samples of drugs examined, | 1,223 | 17,230 |
| Number of samples of good quality, | 990 | 10,836 |
| Number of samples adulterated, as defined by the statutes, | 233 | 6,394 |
| Total examinations of food and drugs, | 7,530 | 170,990 |
| Total samples of good quality, | 5,520 | 119,303 |
| Total samples not conforming to the statutes, | 2,010 | 51,687 |

As stated in the last preceding report, "it is impossible to draw any conclusions as to the extent of the practice of adulteration of food and drugs from the returns of the laboratory, since the aim of the inspectors is not to secure a large number of samples to submit to the analyst, but to seek out, so far as possible, those likely to be adulterated. Therefore, the percentage of samples found to be bad is far above what would be the case were discrimination and discretion not exercised."

Section 7 of chapter 75 of the Revised Laws requires the Board to report annually to the General Court the number of prosecutions made, and an itemized account of the money expended in carrying out the provisions of the law. During the fourteen months covered by this report the number of prosecutions was 409; of which, 395 resulted in conviction and 14 in acquittal. The details are presented below. The amount paid in fines was $7,316, which sum brings the total to $58,230.48.

## PROSECUTIONS.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27): —

*Number of Complaints entered in Court.*

| YEAR. | Food and Other Articles (not including Milk). | Drugs. | Milk. | Total. | Convictions. | Fines imposed. |
|---|---|---|---|---|---|---|
| 1883, | - | 5 | 4 | 9 | 8 | -[1] |
| 1884, | 2 | 1 | 45 | 48 | 44 | -[1] |
| 1885,[2] | 50 | 1 | 68 | 119 | 103 | -[1] |
| 1886,[3] | 10 | - | 10 | 20 | 19 | -[1] |
| 1887, | 30 | - | 34 | 64 | 60 | -[1] |
| 1888, | 22 | - | 43 | 65 | 61 | $2,042 00 |
| 1889, | 74 | - | 66 | 140 | 124 | 3,889 00 |
| 1890, | 78 | - | 24 | 102 | 96 | 3,919 00 |
| 1891, | 96 | 5 | 49 | 150 | 135 | 2,668 00 |
| 1892, | 52 | 12 | 72 | 136 | 123 | 3,661 70 |
| 1893, | 26 | 3 | 67 | 96 | 92 | 2,476 00 |
| 1894, | 14 | - | 76 | 90 | 77 | 2,625 00 |
| 1895, | 13 | 11 | 68 | 92 | 86 | 2,895 30 |
| 1896, | 7 | - | 68 | 75 | 74 | 2,812 20 |
| 1897, | 13 | 1 | 51 | 65 | 64 | 2,756 60 |
| 1898, | 10 | - | 54 | 64 | 62 | 2,060 98 |
| 1899, | 19 | 2 | 26 | 47 | 45 | 1,432 66 |
| 1900, | 45 | 5 | 44 | 94 | 89 | 1,890 70 |
| 1901, | 30 | - | 65 | 95 | 90 | 1,874 70 |
| 1902, | 25 | 3 | 48 | 76 | 74 | 2,617 98 |
| 1903, | 34 | 1 | 44 | 79 | 70 | 1,297 66 |
| 1904, | 6 | 6 | 50 | 62 | 57 | 1,509 00 |
| 1905, | 209 | 27 | 77 | 313 | 275 | 8,486 00 |
| 1906,[4] | 177 | 60 | 171 | 409 | 383 | 7,316 00 |

[1] No record kept.
[2] To May 1, 1886.
[3] Four months only.
[4] Fourteen months, from Sept. 30, 1905.

The following table shows the nature of the offences complained of, the places where the offences were committed, the dates of trial or indictment, and the result of each case: —

*For Sale of Milk not of Good Standard Quality.*

| Name. | Place. | Percentage of Total Solids. | Date. | Result. |
|---|---|---|---|---|
| Jack E. Durkee, | Acton, | 11.38 | Nov. 24, 1905, | Conviction. |
| Wm. T. Howland, | Acushnet, | 10.76 | June 27, 1906, | Conviction. |
| Geo. L. Averill, | Andover, | 11.31 | Nov. 12, 1906, | Conviction. |
| Harry A. Tashijian, | Ashland, | 7.55 [1] | Nov. 23, 1905, | Acquittal. |
| Sarkis H. Tashijian, | Ashland, | 7.27 [1] | Nov. 23, 1905, | Conviction. |
| Wm. E. Taft, | Athol, | 10.80 | Oct. 27, 1906, | Conviction. |
| Orrin H. Keith, | Attleborough, | 11.40 | Oct. 6, 1906, | Conviction. |
| John E. Anderson, | Attleborough, | 11.25 | Oct. 6, 1906, | Conviction. |
| Fred P. Cooper, | Attleborough, | 11.35 | Oct. 6, 1906, | Conviction. |
| Ann M. Brown, | Bedford, | 11.20 | Oct. 31, 1905, | Conviction. |
| M. M. Crafts, | Beverly, | 11.60 | June 26, 1906, | Conviction. |
| Winslow P. Goldsmith, | Beverly, | 11.10 | Mar. 7, 1906, | Conviction. |
| John F. Marshall, | Beverly, | 11.43 | Oct. 30, 1905, | Conviction. |
| Fred P. Warner, | Beverly, | 10.15 [1] | July 5, 1906, | Conviction. |
| Henry F. Woodbury, | Beverly, | 11.04 [1] | Mar. 31, 1906, | Conviction. |
| Henry F. Woodbury, | Beverly, | 11.04 [1] | Mar. 31, 1906, | Conviction. |
| John G. Bailey, | Billerica, | 11.50 | Nov. 4, 1905, | Conviction. |
| Charles Lyons | Billerica, | 11.00 | Nov. 4, 1905, | Conviction. |
| Alexander Gillis, | Brockton, | 10.82 | Jan. 30, 1906, | Conviction. |
| Geo. H. Shurtleff, | Brockton, | 9.87 [1] | Jan. 27, 1906, | Conviction. |
| Wayland H. Sheafe, | Charlton, | 10.78 [1] | Mar. 8, 1906, | Conviction. |
| Wayland H. Sheafe, | Charlton, | 10.78 [1] | Mar. 8, 1906, | Conviction. |
| Fred L. Fletcher, | Chelmsford, | 9.14 [1] | Apr. 27, 1906, | Conviction. |
| Fred L. Fletcher, | Chelmsford, | 9.14 | Apr. 27, 1906, | Conviction. |
| Everett R. Reid, | Chelmsford, | 9.84 [1] | May 11, 1906, | Conviction. |
| Everett R. Reid, | Chelmsford, | 9.84 | May 11, 1906, | Conviction. |
| Benjamin Dine, | Chelsea, | 11.88 | Feb. 9, 1906, | Conviction. |
| Morris Goldman, | Chelsea, | 11.30 | Nov. 1, 1906, | Conviction. |
| John A. D. Schafer, | Chelsea, | 11.77 | Feb. 8, 1906, | Conviction. |
| Henry Smith, | Chelsea, | 11.36 | Feb. 9, 1906, | Acquittal. |
| Antonio Leite, | Cottage City, | 9.37 | Sept. 21, 1906, | Conviction. |
| Antonio Leite, | Cottage City, | 9.37 [1] | Sept. 21, 1906, | Conviction. |
| Albert C. Batchelder, | Danvers, | 10.82 | Nov. 5, 1906, | Conviction. |
| James Wolahan, | Danvers, | 10.84 [1] | Nov. 24, 1906, | Conviction. |
| Chas. H. Wright, | Dedham, | 11.23 | July 25, 1906, | Conviction. |
| Honoro Boule, | Fall River, | 11.20 | Nov. 9, 1905, | Conviction. |
| John N. Burgess, | Fall River, | 10.06 [1] | Nov. 9, 1905, | Conviction. |

[1] Addition of water alleged in complaint.

*For Sale of Milk not of Good Standard Quality* — Continued.

| Name. | Place. | Percentage of Total Solids. | Date. | Result. |
|---|---|---|---|---|
| Theodore Gamache, | Fall River, | 11.26 | Nov. 9, 1905, | Conviction. |
| Alfred Loiselle, | Fall River, | 11.69 | Nov. 9, 1905, | Conviction. |
| Henri Turcotte, | Fall River, | 10.85 | Nov. 9, 1905, | Conviction. |
| Fred. D. Shattuck, | Fitchburg, | 11.40 | Nov. 28, 1905, | Conviction. |
| Zoeth R. Higgins, | Franklin, | 11.00 | Mar. 29, 1906, | Conviction. |
| Thos. E. Spittle, | Gloucester, | 11.57 | July 5, 1906, | Conviction. |
| Geo. E. Waldron, | Gloucester, | 11.19 | July 5, 1906, | Conviction. |
| Hannah Wheeler, | Grafton, | 11.66 | Nov. 21, 1905, | Acquittal. |
| Dennis F. Darling, | Greenfield, | 11.52 | May 17, 1906, | Conviction. |
| Alexander F. Hodgen, | Greenfield, | 11.70 | May 7, 1906, | Conviction. |
| Robert J. Hodgen, | Greenfield, | 11.52 | May 7, 1906, | Conviction. |
| E. C. Eldridge, | Haverhill, | 11.69 | Feb. 6, 1906, | Conviction. |
| Merry C. Oxnard, | Haverhill, | 11.65 | Feb. 6, 1906, | Conviction. |
| Geo. M. Wason, | Haverhill, | 11.60 | Feb. 6, 1906, | Conviction. |
| Geo. M. Wason, | Haverhill, | 11.12 | May 12, 1906, | Conviction. |
| George W. Burgess, | Hingham, | 11.24 | Sept. 25, 1906, | Conviction. |
| George W. Burgess, | Hingham, | 11.24[1] | Sept. 25, 1906, | Conviction. |
| Charles A. Howard, | Holliston, | 10.98 | Mar. 17, 1906, | Conviction. |
| Walter E. Bates, | Hyde Park, | 9.90[1] | Sept. 12, 1906, | Conviction. |
| Jesse H. Whipple, | Ipswich, | 11.00 | Mar. 24, 1906, | Conviction. |
| Richard Bourgeois, | Lawrence, | 11.70 | Mar. 10, 1906, | Conviction. |
| Michael F. Donovan, | Lawrence, | 11.46 | May 16, 1906, | Conviction. |
| Joseph Lamontagne, | Lawrence, | 11.97 | Mar. 10, 1906, | Conviction. |
| James L. McAvoy, | Lawrence, | 11.30 | Mar. 10, 1906, | Conviction. |
| Wm. E. Ralton, | Lawrence, | 10.89[1] | Aug. 22, 1906, | Acquittal. |
| Wm. E. Ralton, | Lawrence, | 10.80[1] | Aug. 29, 1906, | Acquittal. |
| Wm. E. Ralton, | Lawrence, | 7.60[1] | Aug. 29, 1906, | Conviction. |
| Wm. F. Trauskke, | Lawrence, | 11.48 | June 22, 1906, | Conviction. |
| Almon O. Welch, | Leominster, | 10.54 | July 28, 1906, | Conviction. |
| Herbert Dalrymple, | Lexington, | 11.15 | Sept. 29, 1906, | Conviction. |
| Ernest E. McPhee, | Lexington, | 10.71 | Sept. 29, 1906, | Conviction. |
| John F. Burns, | Lowell, | 10.74 | Jan. 24, 1906, | Conviction. |
| Joseph A. Ferron, | Lowell, | 11.77 | Apr. 27, 1906, | Conviction. |
| James J. McCausland, | Lowell, | 11.40 | Jan. 24, 1906, | Conviction. |
| Peter Mawn, | Lowell, | 11.80 | Jan. 24, 1906, | Conviction. |
| John J. Meagher, | Lowell, | 11.27 | Jan. 24, 1906, | Conviction. |
| Peter F. Sullivan, | Lowell, | 11.06 | Jan. 24, 1906, | Conviction. |

[1] Addition of water alleged in complaint.

*For Sale of Milk not of Good Standard Quality* — Continued.

| Name. | Place. | Percentage of Total Solids. | Date. | Result. |
|---|---|---|---|---|
| Wm. McNiff, | Marlborough, | 11.43 | June 2, 1906, | Conviction. |
| Edward P. Gilley, | Medfield, | 8.75 [1] | June 7, 1906, | Conviction. |
| Edward P. Gilley, | Medfield, | 8.75 | June 7, 1906, | Conviction. |
| Jeremiah Doody, | Melrose, | 11.04 | Dec. 20, 1906, | Conviction. |
| Nazareth Boomozian, | Methuen, | 11.20 | May 16, 1906, | Conviction. |
| Robt. Morgan, | Methuen, | 11.38 | Apr. 11, 1906, | Conviction. |
| Napoleon F. Roy, | Methuen, | 11.38 | Apr. 11, 1906, | Conviction. |
| Manuel S. Silva, | Methuen, | 10.83 | June 25, 1906, | Conviction. |
| Patrick J. Twomey, | Methuen, | 10.70 | Aug. 29, 1906, | Conviction. |
| S. Wesley Young, | Methuen, | 11.17 | Apr. 11, 1906, | Conviction. |
| Walter I. Coffin, | Milford, | 11.00 | June 19, 1906, | Conviction. |
| Lewis W. Chamberlain, | Millis, | 11.56 | Mar. 6, 1906, | Conviction. |
| Philip Friedman, | Millis, | 9.23 | Mar. 6, 1906, | Conviction. |
| Philip Friedman, | Millis, | 9.23 [1] | Mar. 6, 1906, | Conviction. |
| Thomas L. Andrews, | New Bedford, | 10.05 [1] | June 27, 1906, | Conviction. |
| Frank E. Childs, | Newton, | 11.31 | Sept. 26, 1906, | Conviction. |
| Michael J. Roulston, | Newton, | 11.18 | Sept. 26, 1906, | Conviction. |
| Wm. H. Freeman, | North Adams, | 11.22 [1] | Nov. 3, 1906, | Conviction. |
| Joseph H. Geddis, | North Adams, | 11.40 | June 29, 1906, | Conviction. |
| Joseph H. Geddis, | North Adams, | [1]11.26<br>[1]11.84 | Nov. 3, 1906, | Conviction. |
| Gordon L. Parris, | North Adams, | 11.22 | Nov. 3, 1906, | Conviction. |
| Willard O. Putnam, | North Andover, | 11.40 | May 16, 1906, | Conviction. |
| Jesse M. James, | North Brookfield, | 8.24 [1] | Aug. 31, 1906, | Conviction. |
| Jesse M. James, | North Brookfield, | 9.06 [1] | Aug. 31, 1906, | Conviction. |
| Gilman P. Young, | North Grafton, | 11.06 | Apr. 21, 1906, | Conviction. |
| Harry P. Young, | North Grafton, | 10.88 | Apr. 21, 1906, | Conviction. |
| Harry P. Young, | North Grafton, | 9.70 [1] | Apr. 21, 1906, | Acquittal. |
| Hosea M. Brown, | North New Salem, | 9.94 [1] | Nov. 24, 1906, | Conviction. |
| Frank W. Bateman, | Norwood, | 11.60 | Sept. 12, 1906, | Conviction. |
| Arthur P. Bodge, | Peabody, | 11.69 | Mar. 7, 1906, | Conviction. |
| Chas. E. Holden, | Peabody, | 11.40<br>11.50 | July 20, 1906, | Conviction. |
| Baptisto Allession, | Pittsfield, | 10.31 | Dec. 14, 1905, | Conviction. |
| Wm. N. Coe, | Pittsfield, | 9.86 | Dec. 14, 1905, | Conviction. |
| Frank Loehr, | Pittsfield, | 10.95 [1] | Dec. 14, 1905, | Conviction. |
| C. A. Cook, | Provincetown, | 10.70 | Sept. 22, 1906, | Pending. |
| A. A. Francis, | Provincetown, | 11.36 | Sept. 22, 1906, | Pending. |

[1] Addition of water alleged in complaint.

*For Sale of Milk not of Good Standard Quality* — Continued.

| Name. | Place. | Percentage of Total Solids. | Date. | Result. |
|---|---|---|---|---|
| Wm. L. Chase, | Quincy, | 11.37 | Feb. 3, 1906, | Conviction. |
| John G. McGregor, | Quincy, | 9.86 | Dec. 17, 1906, | Conviction. |
| Chas. L. Parker, | Quincy, | 11.14 | Mar. 12, 1906, | Conviction. |
| Albert C. Batchelder, | Salem, | 10.52 | Dec. 1, 1906, | Conviction. |
| Albert C. Batchelder, | Salem, | 10.52 [1] | Dec. 1, 1906, | Conviction. |
| Frank S. Brennen, | Salem, | 11.45 | Mar. 7, 1906, | Conviction. |
| Patrick J. Flynn, | Salem, | 11.90 | Nov. 23, 1906, | Conviction. |
| Isaac Wineapple, | Salem, | 11.40 | Apr. 6, 1906, | Conviction. |
| Redmond Welsh, | Sherborn, | 11.43 | Mar. 17, 1906, | Conviction. |
| Anelious O. Chickering, | Spencer, | 9.73 | Mar. 8, 1906, | Conviction. |
| Howard D. Porter, | Springfield, | 11.51 | July 3, 1906, | Conviction. |
| Willard E. Tufts, | Springfield, | 11.88 | Jan. 23, 1906, | Conviction. |
| Frank A. Walters, | Springfield, | 11.87 | Jan. 23, 1906, | Conviction. |
| Martin L. Poole, | Wakefield, | 11.51 | July 24, 1906, | Conviction. |
| Edward G. Gould, | Waltham, | 11.44 | Dec. 19, 1906, | Conviction. |
| Paul J. Polaski, | Waltham, | 11.12 | Nov. 11, 1905, | Conviction. |
| Geo. W. Russell, | Waltham, | 10.60 | Oct. 10, 1906, | Conviction. |
| Gardner A. Teelle, | Waltham, | 11.49 | Oct. 10, 1906, | Conviction. |
| Willard Warren, | Waltham, | 11.42 | Oct. 10, 1906, | Conviction. |
| John Smith, | Ware, | 9.84 [2] | July 30, 1906, | Conviction. |
| James H. Colby, | Wareham, | 10.95 | Sept. 21, 1906, | Conviction. |
| C. Allen Brown, | Watertown, | 11.29 | Nov. 2, 1905, | Conviction. |
| C. Allen Brown, | Watertown, | 11.31 | Dec. 22, 1905, | Acquittal. |
| Dominick Raymond, | Watertown, | 11.31 | Dec. 22, 1905, | Conviction. |
| Chas. Woodlin, | Watertown, | 11.31 | Dec. 22, 1905, | Conviction. |
| Samuel D. Bryden, | Wayland, | 10.50 | Sept. 12, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | 11.40 | Apr. 11, 1906, | Conviction. |
| Robt. A. Watson, | West Andover, | 11.77 | Apr. 6, 1906, | Conviction. |
| Wm. T. Rice, | West Newton, | 11.50 | Nov. 10, 1905, | Conviction. |
| Michael J. Roulston, | West Newton, | 11.20 | Nov. 10, 1905, | Conviction. |
| Wm. H. Bagg, | West Springfield, | 11.32 | Oct. 16, 1906, | Conviction. |
| John DeFern, | Westwood, | 9.96 [1] | Oct. 25, 1906, | Conviction. |
| John DeFern, | Westwood, | 10.24 [1] | Oct. 25, 1906, | Conviction. |
| P. H. Doherty, | Woburn, | 11.50 | Feb. 23, 1906, | Acquittal. |
| Wm. F. Estabrook, | Woburn, | 11.23 [1] | Feb. 20, 1906, | Conviction. |
| John C. Finnegan, | Woburn, | 11.39 | Feb. 20, 1906, | Conviction. |
| John A. Porter, | Woburn, | 10.24 [1] | Nov. 6, 1906, | Conviction. |

[1] Addition of water alleged in complaint. [2] Removal of cream alleged in complaint.

*For Sale of Milk not of Good Standard Quality* — Concluded.

| Name. | Place. | Percentage of Total Solids. | Date. | Result. |
|---|---|---|---|---|
| John A. Porter, | Woburn, | 11.14 | Nov. 6, 1906, | Conviction. |
| Chas. L. Eldredge, | Wrentham, | 10.33 [1] | Nov. 26, 1906, | Conviction. |
| Joshua T. Durfee, | Tiverton, R. I., | 11.11 | Nov. 9, 1905, | Conviction. |
| Edward W. Hicks, | Tiverton, R. I., | 11.70 | Nov. 9, 1905, | Conviction. |

[1] Addition of water alleged in complaint.

*For Sale of Milk containing Added Foreign Matter.*

| Name. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Robt. J. Murray, | Arlington, | Formaldehyde, | Oct. 5, 1906, | Conviction. |
| Mansfield M. Crafts, | Beverly, | Formaldehyde, | June 26, 1906, | Conviction. |
| Chas. H. Dodge, | Beverly, | Formaldehyde, | June 26, 1906, | Conviction. |
| Chas. H. Wright, | Dedham, | Boron compound, | July 25, 1906, | Conviction. |
| Geo. F. Hamilton, | Everett, | Formaldehyde, | July 26, 1906, | Conviction. |
| Ernest E. McPhee, | Lexington, | Coloring matter, [1] | Sept. 29, 1906, | Conviction. |
| Peter F. Sullivan, | Lowell, | Coloring matter, | Jan. 24, 1906, | Conviction. |
| Fred L. Cook, | Newton, | Coloring matter, [1] | Sept. 26, 1906, | Conviction. |
| Arthur J. Green, | North Adams, | Formaldehyde, | July 9, 1906, | Conviction. |
| Nelson Marlowe, | North Adams, | Formaldehyde, | Aug. 14, 1906, | Conviction. |
| Frank W. Bateman, | Norwood, | Formaldehyde, | Sept. 12, 1906, | Conviction. |
| Chas. H. Wright, | Norwood, | Coloring matter, | Nov. 30, 1906, | Discharged. |
| Chas. H. Wright, | Norwood, | Coloring matter, | Nov. 30, 1906, | Conviction. |

[1] Addition of water alleged in complaint.

*For Sale of Adulterated Cream.*

| Name. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Frank F. Este, | Marlborough, | Formaldehyde, | June 2, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Mar. 30, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Mar. 30, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Mar. 30, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Apr. 11, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Apr. 11, 1906, | Conviction. |
| Dana H. Elkins, | Wayland, | Formaldehyde, | Apr. 11, 1906, | Conviction. |

*For Sale of Unmarked Renovated Butter.*

| Name. | Place. | Date. | Result. |
|---|---|---|---|
| John J. O'Hara, | Middleborough, | Dec. 22, 1906, | Conviction. |
| Wm. C. Gearvis, | North Adams, | Nov. 15, 1905, | Conviction. |
| George Tallarico, | North Adams, | Dec. 14, 1905, | Conviction. |
| Geo. D. Lamberton, | Pittsfield, | Dec. 14, 1905, | Conviction. |
| Frank C. Rumery, | Rockland, | Jan. 29, 1906, | Conviction. |
| Thos. S. Litchfield, | Woburn, | Feb. 23, 1906, | Conviction. |

*For Sale of Adulterated Foods other than Milk and Milk Products.*

HAMBURG STEAK.

| Name. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Mossimino Cataldo, | Boston, | Sodium sulphite, | Mar. 1, 1906, | Conviction. |
| Chas. H. Dempsey, | Boston, | Sodium sulphite, | July 6, 1906, | Acquittal. |
| Esther Goldkrand, | Boston, | Sodium sulphite, | Apr. 4, 1906, | Conviction. |
| Manuel D. Johnson, | Boston, | Sodium sulphite, | Jan. 23, 1906, | Conviction. |
| Geo. T. Kelly, | Boston, | Sodium sulphite, | Mar. 1, 1906, | Conviction. |
| Matthew Kniskern, | Boston, | Sodium sulphite, | Jan. 23, 1906, | Conviction. |
| Mardios M. Martin, | Boston, | Sodium sulphite, | Jan. 23, 1906, | Conviction. |
| Michael K. Murphy, | Boston, | Sodium sulphite, | Mar. 30, 1906, | Conviction. |
| Fred P. Purdy, | Boston, | Sodium sulphite, | Nov. 16, 1906, | Conviction. |
| Benj. W. Rodman, | Boston, | Sodium sulphite, | Nov. 16, 1906, | Conviction. |
| Isaac F. Row, | Boston, | Sodium sulphite, | Dec. 13, 1905, | Conviction. |
| Henry F. Gregore, | Chelsea, | Sodium sulphite, | Feb. 7, 1906, | Conviction. |
| Charles D. Johnson, | Chelsea, | Sodium sulphite, | Feb. 7, 1906, | Conviction. |
| Arthur F. Pease, | Holyoke, | Sodium sulphite, | Mar. 15, 1906, | Conviction. |
| John R. Harris, | Lawrence, | Sodium sulphite, | June 22, 1906, | Conviction. |
| Herbert R. Bateman, | North Adams, | Sodium sulphite, | Dec. 22, 1905, | Conviction. |
| Herbert L. King, | Pittsfield, | Sodium sulphite, | Dec. 14, 1905, | Conviction. |
| Walter E. Barry, | Quincy, | Sodium sulphite, | Jan. 20, 1906, | Conviction. |
| Edw. L. Chamberlain, | Reading, | Sodium sulphite, | May 17, 1906, | Conviction. |
| William May, | Springfield, | Sodium sulphite, | Jan. 23, 1906, | Conviction. |
| Fred K. Rood, | Springfield, | Sodium sulphite, | Apr. 6, 1906, | Conviction. |
| Milo K. Woodbury, | Springfield, | Sodium sulphite, | Apr. 6, 1906, | Conviction. |
| Charles A. Wright, | Springfield, | Sodium sulphite, | Apr. 9, 1906, | Conviction. |
| James R. Gardner, | Taunton, | Sodium sulphite, | Jan. 15, 1906, | Conviction. |
| George B. Lawton, | Taunton, | Sodium sulphite, | Dec. 20, 1905, | Conviction.[1] |
| John E. Janes, | Waltham, | Sodium sulphite, | June 12, 1906, | Conviction. |

[1] Appealed.

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

FRANKFORT SAUSAGE AND SAUSAGE MEAT.

| Name. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Wilbert H. Clark, | Attleborough, | Boron compound, | Dec. 8, 1906, | Conviction. |
| Marcellian Sirvian, | Boston, | Sodium sulphite, | Jan. 21, 1906, | Conviction. |
| Paul Varlanina, | Boston, | Boric acid, | Dec. 23, 1905, | Conviction. |
| Christian Wolfrum, | Boston, | Boron compound, | Mar. 23, 1906, | Conviction. |
| Vincent H. Fairey, | Brockton, | Boron compound, | May 8, 1906, | Conviction. |
| Joseph A. Robidoux, | Brockton, | Boron compound, | May 5, 1906, | Conviction. |
| Walter T. Marris, | Chelsea, | Boron compound, | Feb. 7, 1906, | Conviction. |
| Benjamin E. Strout, | Chelsea, | Boron compound, | Feb. 14, 1906, | Conviction. |
| Michael Blake, | Fall River, | Boric acid, | Dec. 5, 1905, | Conviction. |
| Joseph A. Dennis, | Fall River, | Boric acid, | Dec. 5, 1905, | Conviction. |
| Joseph Harrison, | Fall River, | Boric acid, | Dec. 5, 1905, | Conviction. |
| Michael T. Hudner, | Fall River, | Boron compound, | Dec. 12, 1905, | Conviction. |
| James Newsome, | Fall River, | Boron compound, | Dec. 5, 1905, | Conviction. |
| Fred S. Reed, | Fall River, | Boron compound, | Dec. 12, 1905, | Conviction. |
| Fred S. Reed, | Fall River, | Boron compound, | Dec. 12, 1905, | Conviction. |
| Mello Sausa, | Fall River, | Boron compound, | Dec. 5, 1905, | Conviction. |
| Chas. F. Coates, | Greenfield, | Boron compound, | May 17, 1906, | Conviction. |
| John J. Boudreau, | Holyoke, | Boric acid, | Mar. 24, 1906, | Conviction. |
| Clifford J. Gray, | Holyoke, | Boric acid, | Mar. 24, 1906, | Conviction. |
| Aleck Muchlbutt, | Holyoke, | Boric acid, | Mar. 15, 1906, | Conviction. |
| John Curtin, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| Vital Lessard, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| C. Henry Schoenland, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| Charles H. Schoenland, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| Henry C. Schoenland, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| Elnathan C. Brownell, | New Bedford, | Boric acid, | Feb. 20, 1906, | Conviction. |
| Wm. A. Perry, | New Bedford, | Boron compound, | Feb. 20, 1906, | Conviction. |
| Jacob H. Schmidt, | New Bedford, | Boric acid, | Mar. 15, 1906, | Conviction. |
| Jacob H. Schmidt, | New Bedford, | Boric acid, | Mar. 15, 1906, | Conviction. |
| Peter D. Platz, | North Adams, | Boric acid, | Dec. 22, 1905, | Conviction. |
| Daniel J. Cashman, | Springfield, | Boron compound, | Jan. 23, 1906, | Conviction. |
| Harvey B. Frost, | Springfield, | Boron compound, | Jan. 23, 1906, | Conviction. |
| Herman Isenberg, | Springfield, | Boric acid, | May 24, 1906, | Conviction. |
| Thomas E. King, | Springfield, | Boric acid, | Apr. 9, 1906, | Conviction. |
| Wm. O. Sheldon, | Springfield, | Boron compound, | Apr. 6, 1906, | Conviction. |
| Chas. E. Wood, | Taunton, | Boric acid, | Dec. 20, 1905, | Conviction. |
| Walter E. Dickerman, | Whitman, | Boron compound, | Feb. 21, 1906, | Acquittal. |

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

FRANKFORT SAUSAGE AND SAUSAGE MEAT — *Continued.*

| Name. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Fayette A. Amidon, | Worcester, | Boron compound, | Apr. 9, 1906, | Conviction. |
| B. Joseph Bertels, | Worcester, | Boron compound, | May 1, 1906, | Conviction. |
| B. Joseph Bertels, | Worcester, | Boron compound, | May 1, 1906, | Conviction. |
| Geo. M. Keegan, | Worcester, | Boron compound, | May 1, 1906, | Conviction. |

HOGS' HEAD CHEESE.

| | | | | |
|---|---|---|---|---|
| Marcellian Sirvian, | Boston, | Boron compound, | May 2, 1906, | Conviction. |
| Henry C. Schoenland, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| Henry C. Schoenland, | Lawrence, | Boron compound, | June 22, 1906, | Conviction. |
| B. Joseph Bertels, | Worcester, | Boron compound, | May 1, 1906, | Conviction. |

LAMBS' TONGUES.

| | | | | |
|---|---|---|---|---|
| Albert F. Hayward, | Quincy, | Boric acid, | Feb. 3, 1906, | Conviction. |
| John G. Fuller, | Rockland, | Boric acid, | Mar. 22, 1906, | Conviction. |
| Charles R. Cox, | Whitman, | Boron compound, | Mar. 22, 1906, | Conviction. |

POTTED HAM.

| | | | | |
|---|---|---|---|---|
| Wm. C. O'Connor, | Boston, | Borax, | Nov. 6, 1906, | Conviction. |

TRIPE.

| | | | | |
|---|---|---|---|---|
| Edw. L. Brigham, | Attleborough, | Boron compound, | Nov. 26, 1906, | Conviction. |
| William B. Cary, | Lowell, | Boron compound, | July 3, 1906, | Conviction. |

SHRIMP.

| | | | | |
|---|---|---|---|---|
| Bert M. Gove, | Boston, | Boron compound, | Oct. 26, 1906, | Conviction. |
| Herbert S. Litchfield, | Boston, | Boron compound, | Oct. 26, 1906, | Conviction. |
| Smalloff F. Mollins, | Boston, | Boron compound, | Oct. 26, 1906, | Conviction. |
| Benj. F. Thomas, | Boston, | Boron compound, | Oct. 12, 1906, | Conviction. |
| Albert A. White, | Boston, | Boron compound, | Oct. 30, 1906, | Conviction. |
| Ward D. Prescott, | Roslindale, | Boron compound, | Oct. 30, 1906, | Conviction. |
| Wm. Stopford, | Salem, | Boron compound, | Oct. 27, 1906, | Conviction. |

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

JELLIED PIGS' FEET.

| Name. | Place. | Adulterant. | Date. | Result. |
| --- | --- | --- | --- | --- |
| Harry P. Hale, . . | Boston, . . | Boron compound, . | July 6, 1906, | Conviction. |
| Henry Siegel Company, | Boston, . . | Boron compound, . | April term,[1] | Conviction. |

BLOOD PUDDING.

| | | | | |
| --- | --- | --- | --- | --- |
| B. Joseph Bertels, . | Worcester, . | Boron compound, . | May 1, 1906, | Conviction. |

LARD.

| | | | | |
| --- | --- | --- | --- | --- |
| Wm. D. Halward, . | Boston, . . | Decomposed, . . | Jan. 12, 1906, | Conviction. |
| Kayajan A. Simon, . | Chelsea, . . | Cotton seed oil, . | Feb. 7, 1906, | Conviction. |
| Lawrence Loiwa, . | Holyoke, . . | Cotton seed oil, . | Mar. 15, 1906, | Conviction. |
| Robert C. Laberge, . | Lawrence, . | Cotton seed oil, . | Feb. 23, 1906, | Conviction. |
| Frank N. McClure, . | Taunton, . . | Cotton seed oil, . | Jan. 29, 1906, | Conviction. |

MINCE MEAT.

| | | | | |
| --- | --- | --- | --- | --- |
| Harry P. Hale, . . | Boston, . . | Benzoic acid, . . | July 6, 1906, | Conviction. |
| Wm. A. Smith, . . | Cambridge, . | Benzoic acid, . . | June 23, 1906, | Conviction. |
| Daniel F. Lyons,. . | Somerville, . | Benzoic acid, . . | Mar. 29, 1906, | Conviction. |
| Chas. L. Hatch, . . | Winthrop, . | Benzoic acid, . . | June 20, 1906, | Conviction. |

TOMATO KETCHUP.

| | | | | |
| --- | --- | --- | --- | --- |
| Oliver C. Adams, . | Boston, . . | Benzoic acid, . . | June 21, 1906, | Conviction. |
| Guregh G. Baboian, . | Boston, . . | Benzoic acid, . . | Jan. 23, 1906, | Conviction. |
| James J. Egan, . . | Boston, . . | Benzoic acid, . . | Mar. 1, 1906, | Conviction. |
| Henry Siegel Company, | Boston, . . | Benzoic acid, . . | April term,[1] . | Conviction. |
| Henry Siegel Company, | Boston, . . | Benzoic acid, . . | April term,[1] . | Conviction. |
| Lewis L. Partridge, . | Malden, . . | Benzoic acid, . . | Mar. 19, 1906, | Conviction. |

"TOMATO TONER."

| | | | | |
| --- | --- | --- | --- | --- |
| Patrick Keyes, . . | Boston, . . | Benzoic acid, . . | June 21, 1906, | Conviction. |

TOMATO OKRA SOUP.

| | | | | |
| --- | --- | --- | --- | --- |
| Edwin S. Watson, . | Boston, . . | Benzoic acid, . . | Oct. 24, 1906, | Conviction. |

[1] Indictment by grand jury.

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

CHILI SAUCE.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |
| Wm. H. Smith, | Boston, | Benzoic acid, | Oct. 24, 1906 | Conviction. |
| B. Joseph Bertels, | Worcester, | Benzoic acid, | May 1, 1906, | Conviction. |

"ROYAL" TARTAR SAUCE.

| | | | | |
|---|---|---|---|---|
| Joel H. Holton, | Boston, | Benzoic acid, | Oct. 30, 1906, | Conviction. |

"PICCALILL."

| | | | | |
|---|---|---|---|---|
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |

SWEET PICKLES.

| | | | | |
|---|---|---|---|---|
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |

CIDER VINEGAR.

| | | | | |
|---|---|---|---|---|
| Horatio Peasley, | Boston, | Coloring matter, | June 5, 1906, | Conviction. |
| John T. Twombly, | Boston, | Coloring matter, | June 5, 1906, | Conviction. |
| Wm. Farrell, | Cambridge, | Coloring matter, | June 14, 1906, | Conviction. |
| Samuel Goldenberg, | Cambridge, | Coloring matter, | Oct. 5, 1906, | Conviction. |
| Geo. H. Hadley, | Lawrence, | Distilled, coloring matter. | May 16, 1906, | Conviction. |
| Geo. H. Hadley, | Lawrence, | Distilled, coloring matter. | May 16, 1906, | Conviction. |

BUCKWHEAT FLOUR.

| | | | | |
|---|---|---|---|---|
| Henry Siegel Company, | Boston, | Admixture of corn and wheat flour. | April term,[1] | Conviction. |

SPICES.

*Cloves.*

| | | | | |
|---|---|---|---|---|
| Geo. A. Knowles, | Boston, | Clove stems, | May 3, 1906, | Conviction. |

*Mustard.*

| | | | | |
|---|---|---|---|---|
| Gershen Rudnick, | North Adams, | Wheat and turmeric, | Dec. 14, 1905, | Conviction. |

[1] Indictment by grand jury.

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

EXTRACT OF LEMON.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Samuel F. Davis, | Boston, | 0.5 per cent. lemon oil; no formula. | May 3, 1906, | Conviction. |
| Saml. S. Lightbody, | Boston, | No lemon oil, | May 3, 1906, | Conviction. |
| Horace S. Lowell, | Boston, | 0.9 per cent. lemon oil. | May 10, 1906, | Conviction. |
| John E. Jeffers, | Boston, | 1.5 per cent. lemon oil. | June 21, 1906, | Conviction. |
| Fred S. Reed, | Fall River, | Water, | Dec. 12, 1905, | Conviction. |

EXTRACT OF VANILLA.

| | | | | |
|---|---|---|---|---|
| Saml. S. Lightbody, | Boston, | Coumarin, | May 3, 1906, | Conviction. |

EXTRACT OF STRAWBERRY.

| | | | | |
|---|---|---|---|---|
| George A. Knowles, | Boston, | Entirely artificial and not so marked. | May 3, 1906, | Conviction. |

JAMS AND JELLIES.

| | | | | |
|---|---|---|---|---|
| Thomas W. McKee, | Boston, | Benzoic acid, | June 21, 1906, | Conviction. |
| Thomas W. McKee, | Boston, | Benzoic acid, | June 21, 1906, | Conviction. |
| Horace E. Sherman, | Boston, | Benzoic acid, | Apr. 26, 1906, | Conviction. |
| Wm. Y. Wadleigh, | Boston, | Benzoic acid, | June 21, 1906, | Conviction. |
| Joseph Robidaux, | Brockton, | Benzoic acid and coloring matter. | Feb. 9, 1906, | Conviction. |
| Joseph Robidaux, | Brockton, | Apple stock, coloring matter, glucose. | Feb. 9, 1906, | Conviction. |
| Marshall P. Newman, | Cambridge, | Admixture of apples, benzoic acid. | June 19, 1906, | Conviction. |
| Marshall P. Newman, | Cambridge, | Admixture of apples, benzoic acid. | June 21, 1906, | Conviction. |
| Marshall P. Newman, | Cambridge, | Admixture of apples, benzoic acid. | June 21, 1906, | Conviction. |

APPLE BUTTER.

| | | | | |
|---|---|---|---|---|
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |
| Henry Siegel Company, | Boston, | Benzoic acid, | April term,[1] | Conviction. |

MAPLE SUGAR.

| | | | | |
|---|---|---|---|---|
| Bartholomew Marchetti, | Hyde Park, | Refined cane sugar, | June 7, 1906, | Conviction. |
| Gaetano Orsi, | Taunton, | Refined cane sugar, | Mar. 20, 1906, | Conviction. |

[1] Indictment by grand jury.

*For Sale of Adulterated Foods other than Milk and Milk Products* — Continued.

MAPLE SYRUP.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Wm. C. O'Connor, | Boston, | Cane sugar syrup, | Dec. 13, 1905, | Conviction. |
| Wallace F. Staples, | Chelsea, | Cane sugar syrup, | Feb. 1, 1906, | Conviction. |
| Arthur R. Pitts, | Hyde Park, | Cane sugar syrup, | Mar. 26, 1906, | Conviction. |
| John A. Seaman, | New Bedford, | Cane sugar syrup, | Feb. 20, 1906, | Conviction. |
| George Tallarico, | North Adams, | Cane sugar syrup, | Dec. 14, 1905, | Acquittal. |
| John A. Radcliff, | Rockland, | Cane sugar syrup, | Feb. 21, 1906, | Acquittal. |

COCOA.

| | | | | |
|---|---|---|---|---|
| Geo. A. Knowles, | Boston, | Cane sugar, | May 3, 1906, | Conviction. |

CREAM OF TARTAR.

| | | | | |
|---|---|---|---|---|
| Horace S. Lowell, | Boston, | Corn starch, calcium acid phosphate, calcium sulphate, alum. | May 10, 1906, | Conviction. |

GINGER WINE.

| | | | | |
|---|---|---|---|---|
| Arthur E. Cox, | Boston, | Salicylic acid, | July 12, 1906, | Conviction. |

GRAPE JUICE.

| | | | | |
|---|---|---|---|---|
| Henry H. Robinson, | Boston, | Sulphurous acid, sodium sulphite. | May 2, 1906, | Conviction. |

CIDER.

| | | | | |
|---|---|---|---|---|
| Wm. C. O'Connor, | Boston, | Benzoic acid, | Dec. 13, 1905, | Conviction. |

BEER.

| | | | | |
|---|---|---|---|---|
| Wm. H. Hennessey & Co. | Lynn, | Salicylic acid, | May 3, 1906, | Conviction. |

ALE.

| | | | | |
|---|---|---|---|---|
| Wm. J. Molter & Co., | Clinton, | Salicylic acid, | Apr. 10, 1906, | Conviction. |
| Patrick H. Morrison, | Clinton, | Salicylic acid, | Apr. 10, 1906, | Conviction. |
| Wm. C. O'Malley, | Clinton, | Salicylic acid, | Apr. 10, 1906, | Conviction. |
| Thomas Coyne, | Haverhill, | Salicylic acid, | Apr. 21, 1906, | Conviction. |
| Olide Leger, | Haverhill, | Salicylic acid, | Apr. 21, 1906, | Conviction. |

*For Sale of Adulterated Foods other than Milk and Milk Products* — Concluded.

ALE — *Continued.*

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Miles & Johnson, | Lynn, | Salicylic acid, | May 3, 1906, | Conviction. |
| Fred C. Rice, | Pittsfield, | Sodium sulphite, | Jan. 12, 1906, | Conviction. |
| Condon & McAuliffe, | Salem, | Salicylic acid, | Aug. 24, 1906, | Conviction. |
| Joseph Murray, | Taunton, | Salicylic acid, | Mar. 20, 1906, | Conviction. |
| John G. Bieberbach, | Worcester, | Salicylic acid, | Apr. 16, 1906, | Conviction. |

## *For Sale of Adulterated Drugs.*

ALCOHOL.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Samuel Appell, | Boston, | Wood alcohol, | Sept. 6, 1906, | Conviction. |
| David Bonner, | Boston, | Wood alcohol, | Sept. 6, 1906, | Conviction. |
| Reuben Federman, | Boston, | Wood alcohol, | Sept. 6, 1906, | Conviction. |
| Saml. Z. Goldberg, | Boston, | Wood alcohol, | Sept. 6, 1906, | Conviction. |
| Albert G. Smith, | Brockton, | Wood alcohol, | May 25, 1906, | Conviction. |
| Chas. B. Stevens, | Brockton, | 69.04 per cent. alcohol by weight; 76.05 per cent. by volume. | Sept. 20, 1906, | Conviction. |
| Allyn E. Howe, | Stoughton, | Water, | May 14, 1906, | Defaulted. |
| Wm. H. Jackson, | Stoughton, | Water, | May 14, 1906, | Conviction. |

BORAX.

| | | | | |
|---|---|---|---|---|
| Calvin F. Gibbs, | Boston, | Sodium bi-carbonate; no borax in sample. | Oct. 24, 1906, | Conviction. |

BRANDY.

| | | | | |
|---|---|---|---|---|
| Theodore Metcalf Co., | Boston, | Rectified spirits, | Feb. 5, 1906, | Conviction. |
| Archibald Dakin, | Randolph, | Rectified siprits, | Feb. 10, 1906, | Conviction. |
| Lee H. Porter, | Randolph, | Rectified spirits, | Feb. 10, 1906, | Conviction. |

BEESWAX.

| | | | | |
|---|---|---|---|---|
| Edwin R. Fiske, | Greenfield, | 90 per cent. paraffine, | June 27, 1906, | Conviction. |

COCAINE.

| | | | | |
|---|---|---|---|---|
| Charles F. Wright, | Boston, | Without prescription, | Sept. 7, 1906, | Conviction. |
| Charles F. Wright, | Boston, | Not labelled, | Sept. 7, 1906, | Conviction. |

*For Sale of Adulterated Drugs* — Continued.

EXTRACT OF VANILLA.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Theodore Metcalf Company. | Boston, . . | Coumarin, . . | Feb. 5, 1906, | Conviction. |

EXTRACT OF WITCH HAZEL.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Calvin F. Gibbs, . . | Boston, . . | Formaldehyde, . | Oct. 24, 1906, | Conviction. |
| F. James McCarthy, . | Boston, . . | Formaldehyde, . | Aug. 17, 1906, | Conviction. |
| Joseph M. Sisonsky, . | Boston, . . | Wood alcohol, . | July 27, 1906, | Conviction. |
| Joseph M. Sisonsky, . | Boston, . . | Formaldehyde, . | July 27, 1906, | Conviction. |
| Roscoe A. Smith, . | Boston, . . | Formaldehyde, . | Aug. 3, 1906, | Conviction. |
| Bencoin G. Wernick, . | Boston, . . | Formaldehyde, . | July 27, 1906, | Conviction. |
| Geo. R. Hinkley, . . | Brookline, . | Formaldehyde, . | Aug. 4, 1906, | Conviction. |
| Wm. Farrell, . . | Cambridge, . | 9.54 per cent. alcohol; formaldehyde. | Sept. 28, 1906, | Conviction. |
| Chas. L. Curtis, . . | South Framingham. | 9.29 per cent. alcohol by weight; formaldehyde. | Oct. 22, 1906, | Conviction. |
| Fred H. Talcott, . | South Framingham. | 9.43 per cent. alcohol by weight; formaldehyde. | Oct. 9, 1906, | Conviction. |
| W. W. Miner, . . | Ware, . . | Formaldehyde, . | Aug. 9, 1906, | Acquittal. |

OLIVE OIL.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| J. Wells Thompson, . | Adams, . . | Cotton seed oil, . | Dec. 7, 1905, | Conviction. |
| Henry Arsenault, . | Athol, . . | Sesame oil, . . | Oct. 27, 1906, | Conviction. |
| Benj. F. Bradbury, . | Boston, . . | Cotton seed oil, . | Dec. 19, 1905, | Conviction. |
| Arthur L. Green, . | Boston, . . | Cotton seed oil, . | Mar. 9, 1906, | Conviction. |
| Theodore Metcalf Company. | Boston, . . | Cotton seed oil, . | Feb. 5, 1906, | Conviction. |
| Joseph F. O'Donnell, . | Cambridge, . | Cotton seed oil, . | Dec. 11, 1905, | Conviction. |
| Charles H. Howard, . | Everett, . . | Cotton seed oil, . | Dec. 15, 1905, | Conviction. |
| Alfred Robinson, . | Fall River, . | Cotton seed oil, . | Dec. 5, 1905, | Conviction. |
| George G. Leathe, . | Gardner, . . | Cotton seed oil, . | Nov. 14, 1906, | Conviction. |
| Garry W. Russell, . | North Adams, . | Sesame oil, . . | Nov. 17, 1906, | Conviction. |
| Walter A. DeWire, . | Pittsfield, . . | Cotton seed oil, . | Jan. 12, 1906, | Conviction. |
| Robert K. Willard, . | Pittsfield, . . | Cotton seed oil, . | Jan. 12, 1906, | Conviction. |
| Joseph H. Beauvais, . | Springfield, . | Cotton seed oil, . | July 3, 1906, | Conviction. |
| Andrew F. Fearns, . | Taunton, . . | Cotton seed oil, . | Jan. 29, 1906, | Conviction. |

SPIRITS OF CAMPHOR.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Jacob Appell, . . | Gardner, . . | Deficiency in strength, | Nov. 14, 1906, | Conviction. |
| George G. Leathe, . | Gardner, . . | Deficiency in strength, | Nov. 14, 1906, | Conviction. |
| Eugene A. Benjamin, . | North Adams, . | Deficiency in strength, | Nov. 3, 1906, | Conviction. |
| Edward J. Lamone, . | North Adams, . | Deficiency in strength, | Nov. 3, 1906, | Conviction. |

*For Sale of Adulterated Drugs* — Concluded.

TINCTURE OF IODINE.

| NAME. | Place. | Adulterant. | Date. | Result. |
|---|---|---|---|---|
| Benj. F. Bradbury, . | Boston, . . | Low in iodine, . | July 7, 1906, | Conviction. |
| Ernest C. Mains, . | South Boston, . | Low in iodine, . | May 18, 1906, | Conviction. |
| Geo. H. Malley, . . | Boston, . . | Low in iodine, . | Aug. 1, 1906, | Conviction. |
| Frank J. Gilday, . . | Everett, . . | Low in iodine, . | Dec. 15, 1905, | Conviction. |
| Harry P. Elsey, . . | Springfield, . | Low in iodine, . | Oct. 16, 1906, | Conviction. |
| Sidney A. Richards, . | Springfield, . | Low in iodine, . | Oct. 16, 1906, | Conviction. |

WHISKEY.

| | | | | |
|---|---|---|---|---|
| Joseph H. Hart, . . | Canton, . . | Coloring matter, . | May 14, 1906, | Conviction. |
| Archibald Dakin, . | Randolph, . | Rectified spirits, . | Feb. 10, 1906, | Conviction. |
| Lee H. Porter, . . | Randolph, . | Rectified spirits, . | Feb. 10, 1906, | Conviction. |

CATARRH REMEDIES.

| | | | | |
|---|---|---|---|---|
| J. Willard Hayden, . | Boston, . . | Cocaine,. . . | Nov. 16, 1906, | Conviction. |
| Wm. T. Holland, . | Boston, . . | Cocaine,. . . | Oct. 30, 1906, | Conviction. |
| Frank E. Hurd, . . | Boston, . . | Cocaine,. . . | Oct. 12, 1906, | Conviction. |
| Frank E. Hurd, . . | Boston, . . | Cocaine,. . . | Oct. 12, 1906, | Conviction. |
| Frank E. Hurd, . . | Boston, . . | Cocaine,. . . | Oct. 12, 1906, | Conviction. |
| Peter McNiff, . . | Salem, . . | Cocaine,. . . | Nov. 26, 1906, | Conviction. |

Of the cases reported as pending in the last preceding report, 1 for the sale of adulterated cider vinegar resulted in conviction and fine; 2 for the sale of adulterated beer and 8 for the sale of adulterated ale were *nol. pros'd.* Other cases then pending are still to be tried.

The amount paid in fines was $7,266, as follows: —

| | |
|---|---|
| Milk and milk products, . . . . . . . | $2,735 00 |
| Foods other than above, . . . . . . | 3,384 00 |
| Drugs, . . . . . . . . . . | 1,147 00 |
| | $7,266 00 |

The expenditures for the year were as follows:—

*Expenditures under the Provisions of the Food and Drug Acts from Oct. 1, 1905, to Nov. 30, 1906.*

| | |
|---|---|
| Appropriation, 1905, three months, October 1 to December 31, | $3,898 95 |
| Appropriation, 1906, eleven months, January 1 to November 30, | 11,458 33 |
| | $15,357 28 |

| | |
|---|---|
| Salaries of analysts, | $6,377 95 |
| Salaries of inspectors, | 4,762 35 |
| Travelling expenses and purchase of samples, | 2,501 56 |
| Apparatus and chemicals, | 254 10 |
| Printing, | 12 65 |
| Services, cleaning laboratory, | 147 00 |
| Express and telegrams, | 5 88 |
| Sundry laboratory supplies, | 103 14 |
| Typewriting supplies and stationery, | 17 50 |
| Books, | 6 00 |
| Extra services, | 1,159 22 |
| Miscellaneous, | 8 75 |
| Total, | $15,356 10 |

# REPORT OF THE ANALYST.

By Albert E. Leach.

# REPORT OF THE ANALYST.

By Albert E. Leach.

Dr. Charles Harrington, *Secretary, State Board of Health.*

Dear Sir: — I herewith submit my report on the analysis of food and drugs for fourteen months ending Nov. 30, 1906.

## Milk.

The usual tabular statistics follow, showing the localities visited from time to time by the inspectors for the collection of milk.

*Milk from Cities.*

| Cities. | Number above Standard. | Number below Standard. | Total Samples collected. | Total Solids in Lowest Sample. | Number of Skimmed Samples. | Number of Samples colored with — Annatto. | Aniline Orange. | Number of Samples preserved with Formaldehyde. |
|---|---|---|---|---|---|---|---|---|
| Beverly, | 44 | 34 | 78 | 10.15 | 1 | - | - | 3 |
| Boston, | 15 | 5 | 20 | 11.35 | - | - | - | - |
| Brockton, | 65 | 41 | 106 | 9.97 | - | - | 1 | - |
| Cambridge, | 53 | 60 | 113 | 11.14 | - | - | - | - |
| Chelsea, | 58 | 48 | 106 | 10.30 | - | - | - | - |
| Everett, | 17 | 13 | 30 | 11.72 | - | - | - | - |
| Fall River, | 48 | 36 | 84 | 10.06 | - | - | - | - |
| Fitchburg, | 34 | 10 | 44 | 9.71 | 3 | - | - | - |
| Gloucester, | 43 | 17 | 60 | 11.02 | - | - | - | - |
| Haverhill, | 39 | 24 | 63 | 11.12 | - | - | - | - |
| Holyoke, | 30 | 26 | 56 | 9.00 | 2 | - | - | - |
| Lawrence, | 48 | 29 | 77 | 11.17 | - | - | - | - |
| Lowell, | 7 | 17 | 24 | 11.06 | - | 1 | - | - |
| Malden, | 57 | 26 | 83 | 11.36 | - | - | - | 2 |
| Marlborough, | 12 | 1 | 13 | 9.30 | 1 | - | - | - |
| Medford, | 32 | 11 | 43 | 10.33 | - | - | - | - |
| Melrose, | 18 | 8 | 26 | 11.04 | - | - | - | - |
| New Bedford, | 27 | 8 | 35 | 10.05 | - | - | - | - |
| Newburyport, | 47 | 7 | 54 | 11.25 | - | - | - | - |
| Newton, | 35 | 32 | 67 | 10.30 | - | 1 | - | - |
| North Adams, | 129 | 33 | 162 | 11.22 | - | - | - | 2 |
| Pittsfield, | 26 | 11 | 37 | 9.36 | - | - | - | - |
| Quincy, | 46 | 13 | 59 | 9.36 | - | - | - | - |
| Salem, | 114 | 66 | 180 | 10.52 | - | - | - | - |
| Somerville, | 66 | 62 | 128 | 12.03 | - | - | - | - |
| Springfield, | 38 | 32 | 70 | 11.32 | - | - | - | - |
| Taunton, | 76 | 12 | 88 | 10.33 | 5 | - | - | - |
| Waltham, | 96 | 42 | 138 | 10.98 | - | - | - | - |
| Woburn, | 21 | 27 | 48 | 9.00 | 1 | - | - | - |
| Worcester, | 34 | 20 | 54 | 9.72 | 1 | - | - | - |
| Summary, | 1,375 | 771 | 2,146 | - | - | - | - | - |

*Milk from Towns.*

| Towns. | Number above Standard. | Number below Standard. | Total Samples collected. | Total Solids in Lowest Sample. | Number of Skimmed Samples. | Number of Samples colored with Annatto. | Number of Samples preserved with — Formaldehyde. | Number of Samples preserved with — Boric Acid. |
|---|---|---|---|---|---|---|---|---|
| Abington, | 5 | 1 | 6 | 12.00 | - | - | - | - |
| Adams, | 22 | 3 | 25 | 12.10 | - | - | 2 | 1 |
| Amesbury, | 15 | 2 | 17 | 11.78 | - | - | - | - |
| Andover, | 13 | 11 | 24 | 11.31 | - | - | - | - |
| Arlington, | 13 | 9 | 22 | 12.00 | - | - | 2 | - |
| Athol, | 6 | 1 | 7 | 10.80 | - | - | - | - |
| Attleborough, | 80 | 28 | 108 | 10.33 | - | - | - | - |
| Braintree, | 9 | 1 | 10 | 11.80 | - | - | - | - |
| Brookfield, | 9 | 8 | 17 | 8.24 | - | - | - | - |
| Brookline, | 46 | 14 | 60 | 11.73 | - | - | - | - |
| Carlisle, | 7 | - | 7 | 12.11 | - | - | - | - |
| Concord, | 6 | 22 | 28 | 11.65 | - | - | - | - |
| Cottage City, | 10 | 5 | 15 | 9.37 | - | - | - | - |
| Danvers, | 12 | 1 | 13 | 11.47 | - | - | - | - |
| Dedham, | 20 | - | 20 | 12.37 | - | - | - | - |
| Easton, | 9 | - | 9 | 13.00 | - | - | - | - |
| Fairhaven, | 1 | 5 | 6 | 12.26 | - | - | - | - |
| Framingham, | 22 | 5 | 27 | 11.43 | - | - | - | - |
| Greenfield, | 15 | 2 | 17 | 11.52 | - | - | - | - |
| Hingham, | 9 | 1 | 10 | 11.24 | - | - | - | - |
| Hyde Park, | 29 | 25 | 54 | 9.90 | - | - | - | - |
| Ipswich, | 6 | 6 | 12 | 10.20 | - | - | - | - |
| Leominster, | 14 | 3 | 17 | 10.54 | - | - | - | - |
| Lexington, | - | 5 | 5 | 10.71 | - | 1 | - | - |
| Mansfield, | 5 | 2 | 7 | 12.68 | - | - | - | - |
| Marblehead, | 6 | 6 | 12 | 12.23 | - | - | - | - |
| Methuen, | 9 | 7 | 16 | 11.60 | - | - | - | - |
| Middleborough, | 9 | 2 | 11 | 9.58 | 2 | - | - | - |
| Milford, | 35 | 14 | 49 | 10.76 | 2 | - | - | - |
| Montague, | 17 | - | 17 | 12.00 | - | - | - | - |
| Nantucket, | 14 | - | 14 | 13.07 | - | - | - | - |
| Natick, | 46 | 15 | 61 | 9.80 | 2 | - | - | - |
| Needham, | 9 | - | 9 | 12.12 | - | - | - | - |
| Norwood, | 12 | 7 | 19 | 11.23 | - | 1 | 1 | 2 |
| Orange, | 16 | 1 | 17 | 9.60 | - | - | - | - |

*Milk from Towns* — Concluded.

| Towns. | Number above Standard. | Number below Standard. | Total Samples collected. | Total Solids in Lowest Sample. | Number of Skimmed Samples. | Number of Samples colored with Annatto. | Number of Samples preserved with — Formaldehyde. | Boric Acid. |
|---|---|---|---|---|---|---|---|---|
| Palmer, | 3 | 1 | 4 | 11.88 | - | - | - | - |
| Peabody, | 34 | 10 | 44 | 10.58 | - | - | - | - |
| Plymouth, | 14 | 4 | 18 | 11.48 | - | - | - | - |
| Provincetown, | 28 | 6 | 34 | 10.70 | - | - | - | - |
| Reading, | 5 | 5 | 10 | 12.38 | - | - | - | - |
| Revere, | 31 | 14 | 45 | 8.87 | - | - | - | - |
| Rockport, | 10 | 1 | 11 | 11.80 | - | - | - | - |
| Saugus, | 5 | 1 | 6 | 11.13 | - | - | - | - |
| Spencer, | 17 | 2 | 19 | 11.60 | 2 | - | - | - |
| Stoneham, | 16 | 3 | 19 | 9.54 | - | - | - | - |
| Stoughton, | 1 | 9 | 10 | 10.84 | - | - | - | - |
| Swampscott, | 18 | 1 | 9 | 11.62 | - | - | - | - |
| Wakefield, | 13 | 2 | 15 | 11.51 | - | - | - | - |
| Ware, | 18 | 2 | 20 | 9.84 | - | - | - | - |
| Wareham, | 10 | 4 | 14 | 10.95 | - | - | - | - |
| Watertown, | 40 | 41 | 81 | 10.47 | - | - | - | - |
| Wayland, | 7 | 3 | 10 | 10.60 | - | - | - | - |
| Webster, | 11 | 1 | 12 | 11.60 | - | - | - | - |
| Wellesley, | 8 | - | 8 | 12.20 | - | - | - | - |
| Weymouth, | 23 | 8 | 31 | 11.22 | - | - | - | - |
| Williamstown, | 11 | 2 | 13 | 11.70 | - | - | - | - |
| Winthrop, | 14 | - | 14 | 12.07 | - | - | - | - |
| Summary, | 883 | 332 | 1,215 | - | - | - | - | - |

*Milk from Suspected Producers.*

| LOCALITY. | Number above Standard. | Number below Standard. | Total Samples collected. | Total Solids in Lowest Sample. |
|---|---|---|---|---|
| Acton, | - | 9 | 9 | 11.42 |
| Ashland, | - | 11 | 11 | 7.55 |
| Billerica, | - | 18 | 18 | 11.00 |
| Bedford, | - | 8 | 8 | 11.20 |
| Charlton, | - | 5 | 5 | 10.78 |
| Chelmsford, | - | 22 | 22 | 9.14 |
| Dedham, | - | 17 | 17 | 11.20 |
| Franklin, | 1 | 7 | 8 | 11.00 |
| Grafton, | - | 22 | 22 | 9.70 |
| Holliston, | 6 | 6 | 12 | 10.98 |
| Lexington, | 10 | - | 10 | 12.10 |
| Lincoln, | 5 | - | 5 | 12.11 |
| Medfield, | 3 | 1 | 4 | 8.75 |
| Methuen, | 7 | 4 | 11 | 10.65 |
| Millis, | - | 17 | 17 | 9.23 |
| Orange, | 2 | 8 | 10 | 9.94 |
| Spencer, | - | 2 | 2 | 6.80 |
| Topsfield, | 14 | 11 | 25 | 12.24 |
| Wayland, | 3 | 5 | 8 | 10.50 |
| Weston, | - | 6 | 6 | 7.50 |
| Summary, | 51 | 179 | 230 | - |

*Summary of Milk Statistics.*

| | Number above Standard. | Number below Standard. | Total Samples collected. |
|---|---|---|---|
| Cities, | 1,375 | 771 | 2,146 |
| Towns, | 883 | 332 | 1,215 |
| Suspected producers, | 51 | 179 | 230 |
| Miscellaneous, | 7 | 5 | 12 |
| | 2,316 | 1,287 | 3,603 |

The number of towns from which milk was collected will be found to be larger than in former years. The ratio of samples below standard for the period reported was found to be 35.4 per cent., showing a marked improvement over that of previous years. Milk artificially colored was

found in Lexington, Lowell, Newton and Norwood. Milk preserved with formaldehyde was found in Adams, Arlington, North Adams and Norwood.

The following table shows the quality of the milk examined, by months: —

*Quality of Milk, by Months.*

| | 1905. | | | 1906. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | October. | November. | December. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. |
| Number having more than 15 per cent. total solids, | 9 | 6 | 13 | 2 | 6 | 7 | 2 | 4 | 11 | 12 | 10 | 10 | 7 | 18 |
| Number having between 14 and 15 per cent. total solids, | 11 | 25 | 23 | 19 | 6 | 24 | 12 | 18 | 16 | 15 | 18 | 22 | 10 | 40 |
| Number having between 13 and 14 per cent. total solids, | 56 | 72 | 75 | 111 | 65 | 85 | 90 | 78 | 69 | 78 | 60 | 77 | 73 | 141 |
| Number having between 12 and 13 per cent. total solids, | 71 | 71 | 55 | 137 | 121 | 126 | 123 | 163 | 123 | 136 | 151 | 108 | 76 | 113 |
| Number having between 11 and 12 per cent. total solids, | 33 | 24 | 13 | 18 | 39 | 29 | 23 | 29 | 21 | 35 | 60 | 30 | 17 | 10 |
| Number having between 10 and 11 per cent. total solids, | 2 | 2 | 3 | 2 | 8 | 7 | 11 | 8 | 6 | 6 | 6 | 10 | 12 | 9 |
| Number having between 9 and 10 per cent. total solids, | 3 | 4 | 1 | 4 | 5 | 3 | 12 | 2 | 2 | 3 | 3 | 5 | 1 | 2 |
| Number having between 8 and 9 per cent. total solids, | - | 2 | - | - | - | - | - | 1 | - | - | 3 | - | - | - |
| Number having less than 8 per cent. total solids, | - | 8 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| Number above standard, | 79 | 104 | 112 | 134 | 77 | 117 | 227 | 259 | 222 | 243 | 240 | 217 | 92 | 195 |
| Number below standard, | 106 | 111 | 71 | 159 | 173 | 164 | 46 | 34 | 26 | 42 | 71 | 46 | 106 | 133 |
| Total, | 185 | 214 | 183 | 293 | 250 | 281 | 273 | 293 | 248 | 285 | 311 | 263 | 196 | 328 |

*Milk Fraudulently adulterated.*

| Dealer. | Locality. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20°C. | Foreign Substances. |
|---|---|---|---|---|---|---|
| Joshua T. Durfee, | Tiverton, R. I., | 11.11 | 3.40 | 7.71 | 38.7 | |
| J. N. Burgess, | Fall River, | 10.06 | 3.35 | 6.71 | 34.8 | |
| Harry A. Tashjian, | Ashland, | 7.90 | 2.70 | 5.20 | 31.0 | |
| Harry A. Tashjian, | Ashland, | 7.55 | 2.40 | 5.15 | 30.8 | |
| Harry A. Tashjian, | Ashland, | 7.87 | 2.20 | 5.67 | 31.8 | |
| Harry A. Tashjian, | Ashland, | 7.75 | 2.10 | 5.65 | 31.3 | |
| Larkis J. Tashjian, | Ashland, | 8.25 | 2.85 | 5.40 | 31.0 | |
| Larkis J. Tashjian, | Ashland, | 7.80 | 2.50 | 5.30 | 31.8 | |
| Larkis J. Tashjian, | Ashland, | 9.20 | 2.90 | 6.30 | 34.2 | |
| Larkis J. Tashjian, | Ashland, | 7.70 | 2.40 | 5.30 | 31.3 | |

*Milk Fraudulently adulterated* — Continued.

| Dealer. | Locality. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20°C. | Foreign Substances. |
|---|---|---|---|---|---|---|
| Larkis J. Tashjian, . . | Ashland, . . | 7.27 | 2.20 | 5.07 | 30.3 | |
| Larkis J. Tashjian, . . | Ashland, . . | 7.63 | 2.00 | 5.00 | 31.0 | |
| Larkis J. Tashjian, . . | Ashland, . . | 8.35 | 2.30 | 6.05 | 32.6 | |
| Wm. Coe, . . . . | Pittsfield, . . | 9.86 | 2.60 | 7.26 | 37.8 | |
| Frank Loch, . . . | Pittsfield, . . | 10.95 | 3.50 | 7.45 | 38.4 | |
| G. R. Shurtleff, . . | Brockton, . . | 9.87 | 3.15 | 6.72 | 35.0 | |
| P. F. Sullivan, . . . | Lowell, . . . | 11.06 | 3.10 | 7.96 | 39.3 | Annatto. |
| W. F. Estabrook, . . | Woburn, . . | 11.23 | 4.00 | 7.23 | 38.0 | |
| Otis D. Horn, . . . | Charlton, . . | 10.78 | 3.40 | 7.38 | 37.4 | |
| Minnie Chickering, . . | Spencer, . . | 10.69 | 3.40 | 7.29 | 38.5 | |
| Minnie Chickering, . . | Spencer, . . | 9.78 | 2.98 | 6.80 | 36.7 | |
| Minnie Chickering, . . | Spencer, . . | 10.32 | 3.35 | 6.97 | 36.7 | |
| Henry F. Woodbury, . | Beverly, . . | 11.08 | 3.50 | 7.58 | 38.5 | |
| Henry F. Woodbury, . | Beverly, . . | 11.09 | 3.50 | 7.59 | 38.6 | |
| Henry F. Woodbury, . | Beverly, . . | 11.12 | 3.40 | 7.72 | 38.7 | |
| Hugh F. Duggan, . . | Lowell, . . . | 9.97 | 3.20 | 6.77 | 35.5 | Aniline orange. |
| Everett R. Reid, . . | Chelmsford, . . | 9.84 | 3.10 | 6.74 | 36.8 | |
| Harry P. Young, . . | North Grafton, . | 9.70 | 2.45 | 7.24 | 37.5 | |
| Philip Friedman, . . | Millis, . . . | 10.01 | 2.70 | 7.31 | 37.4 | |
| Philip Friedman, . . | Millis, . . . | 9.66 | 2.80 | 6.86 | 37.2 | |
| Philip Friedman, . . | Millis, . . . | 9.23 | 2.40 | 6.83 | 37.0 | |
| Philip Friedman, . . | Millis, . . . | 10.10 | 2.90 | 7.20 | 37.6 | |
| Philip Friedman, . . | Millis, . . . | 9.30 | 2.80 | 6.50 | 36.4 | |
| Philip Friedman, . . | Millis, . . . | 10.14 | 3.00 | 7.14 | 37.6 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 10.07 | 3.40 | 6.67 | 36.8 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.99 | 3.25 | 6.74 | 36.6 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 10.11 | 3.30 | 6.81 | 36.9 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 10.32 | 3.05 | 7.27 | 38.0 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 10.49 | 3.60 | 6.89 | 37.1 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.62 | 2.75 | 6.87 | 36.7 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.35 | 2.70 | 6.65 | 36.2 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.32 | 2.70 | 6.62 | 36.2 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.38 | 2.75 | 6.63 | 36.3 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.14 | 2.60 | 6.54 | 35.8 | |
| Fred L. Fletcher, . . | Chelmsford, . . | 9.33 | 2.70 | 6.63 | 36.2 | |

*Milk Fraudulently adulterated* — Continued.

| Dealer. | Locality. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20°C. | Foreign Substances. |
|---|---|---|---|---|---|---|
| Edward P. Gilley, . . | Medford, . . | 8.75 | 2.65 | 6.10 | 34.4 | |
| T. L. Andrews, . . | New Bedford, . | 10.05 | 3.00 | 7.05 | 37.6 | |
| Fred P. Warren, . . | Ipswich, . . | 10.15 | 2.75 | 7.40 | 36.9 | |
| Albert Davenport, . . | Readville, . . | 9.90 | 3.00 | 6.90 | 37.7 | |
| Luke L. Walden, . . | North Adams, . | 12.12 | - | - | - | Formaldehyde. |
| A. J. Green, . . . | North Adams, . | 13.87 | - | - | - | Formaldehyde. |
| M. M. Crafts, . . . | Beverly, . . | 11.63 | 3.00 | 8.63 | 42.2 | Formaldehyde. |
| Charles H. Dodge, . . | Beverly, . . | 12.50 | - | - | - | Formaldehyde. |
| Charles H. Dodge, . . | Beverly, . . | 12.54 | - | - | - | Formaldehyde. |
| W. S. Dabrowsky, . . | Adams, . . . | 12.70 | - | - | - | Formaldehyde. |
| W. S. Dabrowsky, . . | Adams, . . . | 12.50 | - | - | - | Formaldehyde. |
| Wm. F. Card, . . . | Adams, . . . | 14.08 | - | - | - | Boric acid. |
| Frank W. Bateman, . | Norwood, . . | 11.60 | 3.20 | 8.40 | - | Formaldehyde. |
| Charles H. Wright, . . | Norwood, . . | 11.23 | 3.30 | 7.93 | 39.8 | Boric acid. |
| Charles H. Wright, . . | Norwood, . . | 15.42 | - | - | - | Boric acid. |
| Nelson Marlow, . . | North Adams, . | 13.01 | - | - | - | Formaldehyde. |
| Nelson Marlow, . . | North Adams, . | 13.80 | - | - | - | Formaldehyde. |
| George F. Hamilton, . | Everett, . . . | 12.56 | - | - | - | Formaldehyde. |
| George F. Hamilton, . | Everett, . . . | 12.30 | - | - | - | Formaldehyde. |
| —— —— . . | Peabody, . . | 10.58 | 3.60 | 6.98 | 37.5 | |
| Wm. E. Ralton, . . | Lawrence, . . | 10.80 | 3.20 | 7.60 | 38.5 | |
| Wm. E. Ralton, . . | Lawrence, . . | 10.89 | 3.25 | 7.64 | 38.6 | |
| Jesse M. James, . . | North Brookfield, . | 9.06 | 2.60 | 6.46 | 35.6 | |
| Jesse M. James, . . | North Brookfield, . | 8.24 | 2.25 | 5.99 | 33.5 | |
| Jesse M. James, . . | North Brookfield, . | 8.80 | 3.10 | 5.70 | 32.8 | |
| J. A. C. Ludemann, . | Revere, . . . | 8.87 | 2.80 | 6.07 | 34.5 | |
| Robert J. Murray, . . | Arlington, . . | 12.21 | 3.60 | 8.61 | - | Formaldehyde. |
| Robert J. Murray, . . | Arlington, . . | 12.50 | 3.80 | 8.70 | - | Formaldehyde. |
| Antonio Leite, . . . | Cottage City, . | 9.37 | 2.80 | 6.57 | 34.9 | |
| George Burgess, . . | Hingham, . . | 11.24 | 3.70 | 7.54 | 38.2 | |
| Wm. J. Lamb, . . . | Orange, . . . | 9.60 | 3.00 | 6.60 | 34.4 | |
| John D. Fern, . . . | Westwood, . . | 9.96 | 3.20 | 6.76 | 35.3 | |
| John D. Fern, . . . | Westwood, . . | 10.24 | 3.00 | 7.24 | 37.4 | |
| John D. Fern, . . . | Westwood, . . | 10.50 | 3.20 | 7.30 | 37.6 | |
| John D. Fern, . . . | Westwood, . . | 10.62 | 3.00 | 7.62 | 38.2 | |

*Milk Fraudulently adulterated* — Concluded.

| Dealer. | Locality. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20°C. | Foreign Substances. |
|---|---|---|---|---|---|---|
| John D. Fern, | Westwood, | 9.85 | 3.00 | 6.85 | 35.7 | |
| John D. Fern, | Westwood, | 7.50 | 2.30 | 5.20 | 31.3 | |
| Fred L. Cook, | Newton, | 10.30 | 3.30 | 7.00 | 35.8 | Annatto. |
| Ernest E. McPhee, | Lexington, | 10.71 | 3.80 | 6.91 | 36.4 | Annatto. |
| Jos. A. Geddis, | North Adams, | 11.26 | 3.60 | 7.66 | 38.8 | |
| W. H. Freeman, | North Adams, | 11.22 | 3.80 | 7.42 | 38.2 | |
| John A. Porter, | Woburn, | 10.24 | 2.80 | 7.42 | 37.9 | |
| Hosea M. Brown, | Orange, | 10.11 | 3.40 | 6.71 | 35.3 | |
| Hosea M. Brown, | Orange, | 9.94 | 3.00 | 6.94 | 35.4 | |
| Hosea M. Brown, | Orange, | 10.37 | 3.50 | 6.87 | 35.9 | |
| Hosea M. Brown, | Orange, | 10.26 | 3.30 | 6.96 | 35.8 | |
| Hosea M. Brown, | Orange, | 10.20 | 3.60 | 6.60 | 35.7 | |
| Hosea M. Brown, | Orange, | 10.27 | 3.50 | 6.70 | 35.7 | |
| Hosea M. Brown, | Orange, | 10.44 | 3.60 | 6.84 | 35.9 | |
| Hosea M. Brown, | Orange, | 10 40 | 3.50 | 6.90 | 35.9 | |
| James Wolahan, | Danvers, | 10.84 | 3.20 | 7.64 | 38.5 | |
| Albert C. Batchelder, | Danvers, | 10.82 | 3.00 | 7.82 | 38.8 | |
| Albert C. Batchelder, | Danvers, | 10.52 | 3.20 | 7.22 | 37.5 | |
| Charles L. Eldredge, | Wrentham, | 10.33 | 3.30 | 7.03 | 36.5 | |
| Atwood's New Market, | Stoughton, | 11.65 | 3.55 | 8.10 | 38.5 | |
| Thomas P. Cronan, | Milford, | 10.92 | 3.75 | 7.17 | 36.3 | |
| James W. Fletcher, | Milford, | 10.76 | 3.40 | 7.36 | 36.0 | |
| Jesse Doody, | North Saugus, | 11.04 | 3.80 | 7.24 | 37.2 | |
| N. Shaw, | Plymouth, | 11.48 | 3.83 | 7.63 | 38.1 | |
| Charles H. Wright, | Norwood, | - | - | - | - | Annatto. |

## *Milk with Added Water.*

The accompanying table, showing the cases of fraudulently adulterated samples of milk during the period of the report, indicate an unusually large proportion of watered milk. All the samples recorded in the table contained added water, with the exception of a few samples of good standard quality adulterated with an added preservative. Before the refractometric method of examining milk serum was devised, it was impossible to allege positively the addition of water, unless the sample as analyzed was found to stand lower in total solids or in solids not fat than the minimum limit for Holstein milk of known purity; it being a well-

known fact that of all breeds of cows the Holstein can give the poorest quality of milk. This limitation allowed us to place in the watered class extreme cases only, so that formerly many samples that were actually watered were necessarily passed by as simply below the standard.

In view of the fact that $50 is the minimum fine, if the milk can be proved to be actually watered, while the fine for milk simply below the standard may be made as low as the judge sees fit to impose, the importance of being able to distinguish between the two classes and to prove the presence of added water is evident.

The refractometric method as first published in the annual report of the analyst in 1903 has since been thoroughly tested in a number of laboratories, and its reliability has been established. As now embodied in the provisional methods of the Association of Official Agricultural Chemists the method is as follows: —

*Detection of Added Water.* — To 100 cubic centimeters of milk at a temperature of about 20° C. add 2 cubic centimeters of 25 per cent. acetic acid (sp. gr. 1.0350) in a beaker, and heat the beaker, covered with a watch glass, in a water bath for twenty minutes at a temperature of 70° C. Then place the beaker in ice water for ten minutes and separate the curd from the serum by filtration through a 12.5 centimeter plaited filter.

Transfer about 35 cubic centimeters of the serum to one of the beakers that accompanies the control-temperature bath used in connection with the Zeiss immersion refractometer, the bath being of the type with openings in the top for ten beakers. Place the beaker in one of the openings, use the ground glass strip at the bottom of the bath, and by means of the regular refractometer heater or similar device maintain a constant temperature of exactly 20° C. in the water surrounding the beaker, using a delicate thermometer, reading to tenths of a degree. Immerse the end of the refractometer in the serum in the beaker, and when the temperature is exactly 20° take the reading on the scale.

If the temperature varies from 20°, the reading may be calculated on that basis by means of a correction table. A reading below 39 indicates added water; between 39 and 40 the same is suspicious.

To any one not familiar with the possibilities of the Zeiss immersion refractometer the difference in refraction between the sera of pure and watered milk is surprising, but it is this physical characteristic that will, in most cases, give a positive clue as to whether or not the milk is pure. Data on as many samples of milk of known purity as possible have been collected, with a view to establishing the minimum refractometric reading for the serum of pure milk. Most attention has been paid to milk from Holstein cows. In fact, we have sought out as far as possible particular cows which gave low-standard milk, and it has been our fortune to find a good many such. At first we were inclined to adopt 40 as the minimum refractometric reading of the serum of pure

milk at 20°C., but since occasional samples were found to run below this figure, we have later been inclined to adopt 39. If milk is found to give a refraction reading lower than 39, it is safe to allege watering, especially if in addition to this, the solids not fat stand below 7.3 per cent.

The following tables are of interest, as they show, in summarized form, refractometric and analytical results from a large number of milk samples from three widely separated localities, namely, Massachusetts, New Jersey and Great Britain: —

*Milk of Known Purity.*

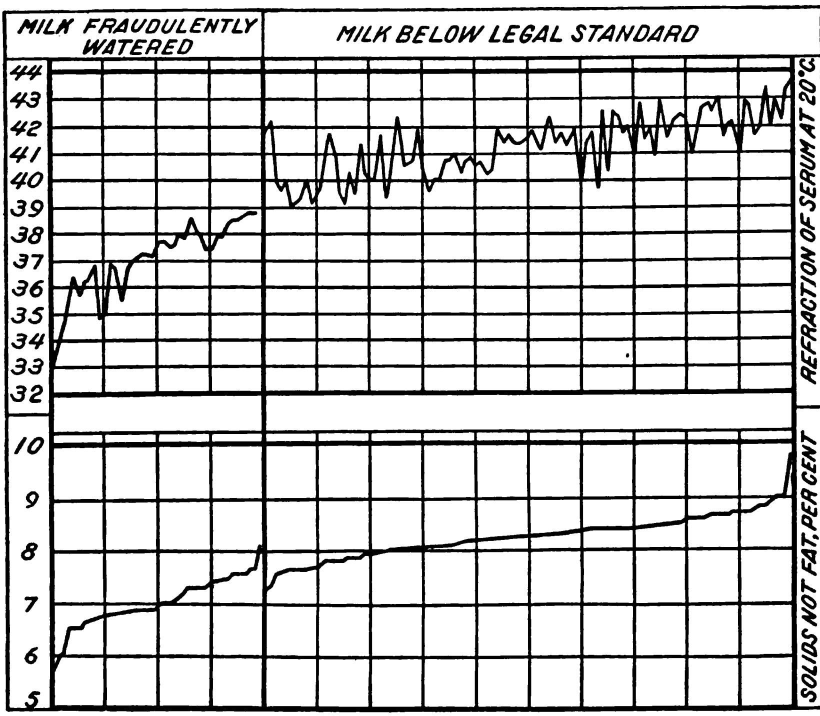
| Classification according to Total Solids (Per Cent.). | Limits. | Massachusetts State Board of Health. | | | | | New Jersey State Laboratory of Hygiene. | | | | | Liverpool, England. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Samples. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20° C. | Number of Samples. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20° C. | Number of Samples. | Total Solids (Per Cent.). | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20° C. |
| Above 15, | Highest | 2 | 15.14 | 6.60 | 8.54 | 43.2 | - | - | - | - | - | 1 | 15.12 | 5.90 | 9.22 | 42.62 |
| | Lowest | | 15.10 | 6.00 | 9.10 | 43.5 | | | | | | | | | | |
| 14 to 15, . | Highest | - | - | - | - | - | 3 | 14.72 | 5.85 | 9.16 | 43.6 | 10 | 14.87 | 6.14 | 10.25 | 43.60 |
| | Lowest | | | | | | | 14.01 | 5.20 | 8.87 | 42.5 | | 14.00 | 4.26 | 8.66 | 41.62 |
| 13 to 14, . | Highest | 1 | 13.43 | 4.35 | 9.08 | 43.6 | 2 | 13.21 | 4.25 | 9.11 | 43.7 | 38 | 13.98 | 5.20 | 9.48 | 44.15 |
| | Lowest | | | | | | | 13.16 | 4.10 | 8.91 | 43.3 | | 13.03 | 3.68 | 8.45 | 40.55 |
| 12 to 13, . | Highest | 13 | 12.96 | 4.50 | 9.04 | 44.4 | 1 | 12.42 | 3.80 | 8.62 | 42.2 | 73 | 12.92 | 4.54 | 9.94 | 43.50 |
| | Lowest | | 12.11 | 3.55 | 8.16 | 41.4 | | | | | | | 12.05 | 2.84 | 7.82 | 40.00 |
| 11 to 12, . | Highest | 22 | 11.93 | 3.60 | 8.49 | 44.1 | 2 | 11.96 | 3.60 | 8.96 | 42.5 | 50 | 11.97 | 5.36 | 9.40 | 43.00 |
| | Lowest | | 11.03 | 2.60 | 7.43 | 39.9 | | 11.74 | 3.00 | 8.14 | 40.6 | | 11.10 | 2.30 | 7.30 | 39.13 |
| 10 to 11, . | Highest | 8 | 10.88 | 3.45 | 7.99 | 41.8 | - | - | - | - | - | 7 | 10.98 | 2.86 | 8.63 | 41.60 |
| | Lowest | | 10.45 | 2.55 | 7.43 | 39.0 | | | | | | | 10.23 | 2.18 | 7.46 | 40.60 |

*Milk collected from Dealers.*

| Classification. | Limits and Average. | Massachusetts State Board of Health. | | | | | New Jersey State Laboratory of Hygiene. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Samples. | Total Solids (Per Cent.) | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20° C. | Number of Samples. | Total Solids (Per Cent.) | Fat (Per Cent.). | Solids not Fat (Per Cent.). | Refraction of Serum at 20° C. |
| Above standard of solids (12 per cent.). | Highest | 34 | 14.54 | 5.15 | 10.06 | 45.0 | 48 | 15.37 | 6.60 | 9.20 | 44.6 |
| | Lowest | | 12.00 | 3.10 | 7.90 | 40.0 | | 12.00 | 3.00 | 7.61 | 39.6 |
| | Average | | 13.14 | 4.02 | 9.12 | 42.9 | | 12.97 | 4.17 | 8.80 | 42.5 |
| Below standard of solids (12 per cent.) but not watered. | Highest | 31 | 11.65 | 3.55 | 9.20 | 43.9 | 33 | 11.97 | 4.00 | 9.90 | 43.3 |
| | Lowest | | 10.27 | 1.50 | 7.77 | 39.0 | | 9.12 | 0.35 | 7.35 | 39.0 |
| | Average | | 11.04 | 2.85 | 8.19 | 40.7 | | - | - | - | - |
| Milk with added water, | Highest | 58 | 11.35 | 4.00 | 7.77 | 38.8 | 17 | 12.80 | 6.30 | 7.27 | 38.7 |
| | Lowest | | 4.69 | 0.25 | 4.44 | 28.7 | | 9.64 | 2.60 | 6.30 | 35.8 |

At first it was thought that a definite relationship existed between the solids not fat in milk and the refraction of its serum. It has even been claimed that the variation between these two factors in milk from various sources is proportional.

The accompanying chart has been prepared, which shows quite clearly the relationship, if any, between the two factors. The lower curve shows




the percentage of solids not fat, while the higher curve shows the refraction of milk serum of the same samples. Samples are arranged in the order of the solids not fat, the refractometric reading corresponding with the solids not fat in each sample being readily apparent, as it is placed along the same ordinate in the chart. The first 37 samples were pronounced watered, being below the minimum of 39 in refraction. Even if 7.3 per cent. could be safely adopted as the minimum for solids not fat for pure milk, it will be seen by reference to the chart that only 25 samples of milk could have been condemned as watered from the solids not fat alone, and that 12 samples actually watered would escape detection. It is also apparent that there is no fixed proportion by any means between the two constants, since in some cases a milk low in solids not fat has a high refraction, and *vice versa*.

### *Cream.*

Seven samples of cream were this year found to contain formaldehyde as a preservative, out of 104 samples examined. No other preservative was found this year, nor were any samples found to contain calcium sucrate. Adulterated samples of cream were taken from D. H. Elkins of Cochituate, and from the Esté Creamery Company of Marlborough.

### *"Evaporated Cream" and Condensed Milk.*

The following table shows the analyses in full of new brands of these products examined, while, in the case of brands reported in previous years, determinations only of total solids and of ash were made, with a view to indicating the fat in the original milk by calculation. The latter factor was in each case calculated from the percentage of ash by the method published in the report of last year.

*Condensed Milk.*

| BRAND. | Total Solids (Per Cent.). | Water (Per Cent.). | Milk Solids (Per Cent.). | Cane Sugar (Per Cent.). | Milk Sugar (Per Cent.). | Proteids (Per Cent.). | Ash (Per Cent.). | Fat (Per Cent.). | Fat in Original Milk (Per Cent.). |
|---|---|---|---|---|---|---|---|---|---|
| Autocrat, | 74.15 | 25.85 | 34.15 | 40.00 | 13.52 | 12.31 | 1.69 | 6.38 | 2.65 |
| Brookside, | 77.14 | 22.86 | 31.81 | 45.33 | 14.38 | 10.42 | 1.61 | 5.40 | 2.35 |
| Commander, | 75.32 | 24.68 | 30.97 | 44.35 | 13.46 | 9.66 | 1.55 | 6.30 | 2.85 |
| Darling, | 86.30 | 13.70 | 32.48 | 53.82 | 14.80 | 9.57 | 1.51 | 6.60 | 3.08 |
| Defiance, | 72.05 | 27.95 | - | - | - | - | 1.47 | 8.40 | 4.00 |
| Empire State, | 76.04 | 23.96 | 32.21 | 43.83 | 15.70 | 10.00 | 1.34 | 5.17 | 2.68 |
| Empress, | 76.00 | 24.00 | 31.04 | 44.96 | 12.06 | 8.84 | 1.68 | 8.46 | 3.16 |
| Fort Orange, | 76.62 | 23.38 | 28.96 | 47.66 | 11.42 | 7.44 | 1.70 | 8.40 | 3.45 |
| Glen Island, | 74.79 | 25.21 | 30.62 | 44.17 | 12.64 | 10.12 | 1.86 | 6.00 | 2.25 |
| Gray, | 72.15 | 27.85 | 29.74 | 43.41 | 14.80 | 8.34 | 1.80 | 4.80 | 1.87 |
| Ideal, | 76.60 | 23.40 | 28.97 | 47.63 | 12.28 | 9.17 | 1.52 | 5.10 | 2.04 |
| Jersey, | 75.87 | 24.13 | - | - | - | - | 1.27 | 7.20 | 3.95 |
| Middlesex, | 69.56 | 30.44 | - | - | - | - | 1.29 | 6.90 | 3.71 |
| None Such, | - | - | - | - | - | - | 1.63 | 7.20 | 3.10 |
| O'Keefe's, | - | - | - | - | - | - | 1.62 | 8.10 | 3.50 |
| Rob Roy, | - | - | - | - | - | - | 1.80 | 7.50 | 2.92 |
| Smith's Elk, | 75.60 | 24.40 | 32.76 | 42.84 | 12.36 | 11.18 | 1.42 | 7.80 | 2.95 |
| Table, | 76.52 | 23.48 | 37.49 | 39.03 | 16.60 | 12.02 | 1.52 | 7.35 | 3.38 |
| White Top, | 76.30 | 23.70 | 32.21 | 44.09 | 12.76 | 9.90 | 1.75 | 7.80 | 3.12 |

*"Evaporated Cream."*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A & P, | - | 68.48 | 31.52 | - | 12.18 | 9.81 | 1.53 | 7.80 | 3.57 |
| Borden's Peerless, | - | 69.15 | 30.85 | - | 11.40 | 9.21 | 1.62 | 8.40 | 3.66 |
| Gilt Edge, | - | 61.04 | 38.96 | - | 12.88 | 9.04 | 1.40 | 7.26 | 3.65 |
| Gold Brand, | - | 70.63 | 29.37 | - | 11.24 | 8.98 | 1.42 | 8.70 | 4.29 |
| Highland, | - | 74.97 | 25.03 | - | 10.22 | 5.31 | 1.15 | 7.80 | 4.73 |
| Hustler, | - | 68.75 | 31.25 | - | 13.64 | 9.83 | 1.73 | 6.60 | 2.65 |
| Silver Cow, | - | 69.50 | 30.50 | - | 12.30 | 9.75 | 1.35 | 7.05 | 3.65 |
| St. Charles, | - | 71.00 | 29.00 | - | 11.14 | 8.38 | 1.22 | 7.50 | 4.35 |
| Van Camps Top Notch, | - | 72.80 | 27.20 | - | 10.48 | 7.21 | 1.25 | 8.40 | 4.70 |

All 9 brands of evaporated cream were placed in the adulterated class, being in no case entitled to be called cream. They were in every instance simply milk condensed without cane sugar, and in no sense resembled cream, excepting in consistency. Indeed, in one instance the so-called cream was apparently condensed from skimmed milk. A number of brands of condensed milk are shown which were condensed from skimmed milk. The Brookside, Glen Island, Gray's and Ideal brands were thus classed as adulterated.

### *Butter.*

One hundred and twenty-three samples were examined, 7 of which were adulterated. Six of these samples were found to be renovated butter and one consisted of oleomargarine.

## Foods exclusive of Milk.

The table on page 399 presents a summary of foods examined during the year. Under the following headings only such cases as call for special comment are cited.

### *Canned Fish, Fruits and Vegetables.*

Under this heading are included a number of samples of canned salmon, the fat of which was examined by the refractometer to determine whether or not other fish had been substituted. In all cases no other fish than salmon was found.

Upwards of 20 samples of asparagus, blueberries, beans, corn, raspberries and spinach were examined for preservatives, and all were found to be free therefrom.

Van Camp's Tomato Soup, manufactured by the Van Camp Packing Company of Indianapolis, Ind., was found to contain benzoic acid, also the tomato soup of Libby, McNeil & Libby. The same preservative was found in Seal Brand Okra and Tomato Soup, made by P. J. Ritter Conserve Company of Philadelphia.

Samples of corn and other vegetables were examined for saccharin, which in some instances was found present.

### *Cereal Flours.*

The single sample classed as adulterated was buckwheat flour, found to contain an admixture of corn and wheat flours. This was the Hazel Brand, sold by the Henry Siegel Company of Boston.

*Cider.*

Four samples were found to be adulterated, containing added preservatives. A sample of Duffy's cider, put up by the American Fruit Product Company of Rochester, N. Y., was found to contain benzoic acid. A sample of the same brand afterwards examined was found to be free from this preservative. Russet Apple Cider, manufactured by J. R. Magullion Company of Boston, was found to contain salicylic acid.

*Cocoa.*

A sample of Challenge Lunch Cocoa, product of the Importers' Tea and Coffee Company of Boston, was found to contain an admixture of sugar, but to have the label obscurely marked.

*Coffee Substitutes.*

A number of these preparations, variously styled "Coffee substitutes," "Cereal coffees," etc., were examined during the year. One brand, the Old Grist Mill, made by Potter & Wrightington of Boston, purporting to be made from entire wheat only, and to be "the best substitute for coffee," was found to contain wheat, peas, pea hulls, and a large admixture of coffee itself.

*Confectionery.*

Upwards of 40 samples were examined for the presence of paraffin. The persistence with which complaints were received concerning the wide-spread use of paraffin in caramels and so-called molasses kisses resulted in a very careful examination of all available brands. In no case was paraffin found in caramels. In two instances "kisses" were found to contain from 3 to 5 per cent. of paraffin.

In examining the paraffin, a weighed portion of the sample was dissolved by prolonged treatment with hot water. The insoluble portion floating at the top, consisting in most instances of fat, was mechanically removed, dissolved in petroleum ether and filtered. The residue on evaporation of the petroleum ether was afterwards examined by the refractometer. If the refraction corresponded to butter or any of the common fats used in confectionery, no further examination was made. If, however, the refraction indicated the presence of paraffin, the residue was further subjected to the usual process of saponification, and the purified unsaponifiable residue submitted to examination with the refractometer.

Several samples of confectionery suspected of containing poison were examined but in no instance was any injurious ingredient found.

*Flavoring Extracts.*

The following brands of flavoring extracts were pronounced adulterated: —

***Analyses of Adulterated Brands of Flavoring Extracts.***

| Extract. | Brand. | Manufacturer or Wholesaler. | Result of Analysis. |
|---|---|---|---|
| Lemon, | - | St. John & Co., New York, | 0.1 per cent. lemon oil; erroneous formula. |
| Lemon, | - | Pembroke Manufacturing Company, Providence, R. I. | 0.88 per cent. lemon oil. |
| Lemon, | - | Atlantic and Pacific Tea Company, New York. | 2.94 per cent. lemon oil. |
| Lemon, | Standard, | A. B. Jackson & Co., New York. | 0.5 per cent. lemon oil. |
| Lemon, | Eagle, | Eagle Extract Company, Boston. | Trace only of lemon oil. |
| Lemon, | Continental, | Continental Extract Company, Chelsea. | Trace only of lemon oil. |
| Lemon, | - | Horace I. Lowell, Boston, | 0.9 per cent. lemon oil. |
| Lemon, | Harold's, | Harold & Co., Cambridge, | 0.9 per cent. lemon oil; no formula. |
| Lemon, | Favorite, | John T. Connor Co., Boston, | 0.3 per cent. lemon oil; no formula. |
| Lemon, | Royal, | John Burnett & Co., Boston, | 0.3 per cent. lemon oil; no formula. |
| Lemon, | Delmonico, | Fulton Chemical Company, Boston. | 1.0 per cent. lemon oil; no formula. |
| Lemon, | Regal, | Royal Extract Company, Boston. | 0.3 per cent. lemon oil; no formula. |
| Lemon, | Lexington, | Wason & Co., Boston, | 0.2 per cent. lemon oil; no formula. |
| Vanilla, | Water White, | Theodore Metcalf Company, Boston. | Admixture of coumarin; absence of vanilla resin. |
| Vanilla, | Colonial, | Pitts, Kimball Company, Boston. | Contains coumarin. |
| Vanilla, | Ten Cent, | Parker's, | Contains coumarin; erroneous formula. |
| Vanilla, | Kidder's Concentrated, | Kidder & Co., Boston, | Contains coumarin; erroneous formula. |
| Vanilla, | Ragus, | Ragus Tea and Coffee Company, New York. | Contains coumarin; erroneous formula. |
| Vanilla, | Dime, | Highland Extract Company, Boston. | Erroneous formula. |
| Vanilla, | Royal, | John Burnett & Co., Boston, | Entirely artificial; colored with a coal tar dye. |
| Vanilla, | Mexican Vanola, | Oritz & Jaoquin, Mexico City, | A preparation containing coumarin. |
| Strawberry, | Challenge, | Importers' Tea and Coffee Company, Boston. | Artificial; not marked. |

In many cases brands of flavoring extracts classed as adulterated in the above table could have been legally sold except for the lack of the formula stating the ingredients, and in some cases where the formula was present it was found not to agree with the actual analysis of the goods.

*Gluten.*

There is a great tendency toward improvement in the preparations now found on the market variously styled gluten, diabetic flour, etc., intended for the use of diabetic patients. Formerly the patient was led

to believe, by the label on the package, that the preparation in question contained no starch, and consisted for the most part or entirely of nitrogenous material. Now, however, most brands contain on the label either the percentage of starch or of proteids present. Four brands were examined, all marked on the label with the percentage of proteids. These were classed as adulterated because the proteids found on analysis were below those stated on the label, but in nearly every case the difference between the label and the result shown on analysis was slight.

### *Grape Juice.*

Two brands of this preparation were classed as adulterated. One the product of John C. Meier of Silverton, O., H. H. Robinson & Company being the Boston distributers. This was found to be preserved with sulphurous acid. The other was put out by Adolph Prince of New York, and was found to contain salicylic acid.

### *Jams and Jellies.*

In this class of goods, as usual, the ratio of adulteration is high. Adulterants, as in past years, consisted for the most part of apple stock colored with coal tar dyes, and of preservatives, generally benzoic acid. An incomplete or erroneous formula and in some instances entire absence of formulas, render many of the brands illegal that otherwise might be sold under the law.

The following brands were those condemned: —

*Published Results of Analyses of Adulterated Brands of Jams and Jellies.*

| Sample. | Brand. | Manufacturer or Wholesaler. | Result of Analysis. |
|---|---|---|---|
| Damson preserve, . . | Yankee, . . | Althaus & Co., Providence, R. I. | Apple stock; colored with coal tar dye, preserved with benzoic acid. |
| Currant jelly, . . . | Yankee, . . | Althaus & Co., Providence, R. I. | Apple stock; colored with coal tar dye, preserved with benzoic acid. |
| Raspberry jam, . . | - | Webster Preserving Company, Webster, N. Y. | Preserved with benzoic acid. |
| Strawberry preserve, . | Schimmel's, . | American Preserving Company, Philadelphia, Pa. | Apple stock; preserved with benzoic acid. |
| Strawberry jam, . . | - | T. W. McKee, Boston, . | Preserved with benzoic acid; no formula. |
| Raspberry jam, . . | - | T. W. McKee, Boston, . | Preserved with benzoic acid; no formula. |
| Red Raspberry preserve, | - | Lutz & Schramm Co., Allegheny, Pa. | Preserved with benzoic acid; no formula. |
| Strawberry jam, . . | Our Triumph, | Webster Thomas Co., Boston. | Preserved with benzoic acid; no formula. |
| Currant jelly, . . . | - | Ritter Conserve Company, Philadelphia, Pa. | Preserved with benzoic acid; no formula. |
| Strawberry jam, . . | - | American Preserve Company, Philadelphia, Pa. | Preserved with benzoic acid; no formula. |

### *Lard.*

Five samples were condemned as adulterated, 4 by reason of the presence of cotton-seed oil or stearin, and 1 being badly decomposed, showing an "acid value" of 3.36. Limits of "acid value" for pure lard are fixed by Lewkowitsch at 0.54 and 1.28. In the examination of lard for adulterants, all samples submitted are melted and the fat examined by the refractometer. In nearly every instance adulteration will be proved by the refraction, taken in connection with the odor and consistency of the fat. Presence of cotton-seed oil is confirmed by the Halphen test, while beef stearin is best shown by the microscopical appearance of the crystals according to the Belfield method.

### *Lime Juice.*

Brands of lime juice condemned as adulterated were those of the Blue Hill Preserving Company of Boston (which contained 20 per cent. of added water and had no formula) and J. P. W. von Lear of Boston (containing 60 per cent. of added water, not stated in the formula).

### *Malt and Barley.*

Six samples of these preparations, believed to be of known purity, were examined for the natural presence of fluoride, which was found in the merest traces in 5 of them.

### *Malt Liquors.*

These, as usual, were examined for preservatives, particular attention being naturally given to bottled goods. The following brands were classed in the "Monthly Bulletin" as adulterated: —

*Published Analyses of Adulterated Brands of Malt Liquors.*

| Brand. | Manufacturer or Wholesaler. | Preservative. |
|---|---|---|
| - - | E. S. Pierce & Co., Worcester, | Salicylic acid. |
| - - | Thos. J. Donaher & Co., Worcester, | Salicylic acid. |
| - - | D. J. Donaher & Co., Worcester, | Salicylic acid. |
| - - | J. W. McKran & Co., Worcester, | Salicylic acid. |
| - - | P. McLaughlin, Worcester, | Salicylic acid. |
| - - | M. F. O'Day, Worcester, | Salicylic acid. |
| Cream ale, | C. H. Evans & Sons, | Sulphurous acid. |
| Ale, | W. H. Hennessey, Lynn, | Salicylic acid. |
| Ale, | Miles & Johnson, Lynn, | Salicylic acid. |
| India pale ale, | C. H. Evans & Sons, Hudson, N. Y., | Erroneous formula; salicylic and sulphurous acid. |
| Old stout porter, | A. G. Van Nostrand, | Salicylic acid. |

### *Maple Products.*

Maple sugar and maple syrup, mixed with varying amounts of refined cane sugar, are frequently sold with formulas which state erroneously the percentage of the mixture. Formerly the determination of a number of constants, including the total ash, water-soluble ash and the so-called Hortvet number, were considered necessary in judging the amount of cane sugar present. Experience has shown that the simple determination of the total ash is for the most part sufficient, assuming ash of pure maple sugar, expressed on a dry basis, to be 0.8 per cent.

The following are brands of maple sugar and maple syrup classed in the "Monthly Bulletin" as being adulterated: —

*Published Results of Analyses of Adulterated Brands of Maple Syrup and Maple Sugar.*

| BRAND. | Manufacturer or Wholesaler. | Cane Sugar Syrup (Per Cent.). |
|---|---|---|
| Milford, Vermont, Syrup, | Henry Siegel Company, Boston, agents, | 80 |
| - - | Vermont Syrup Refining Company, Brooklyn, N. Y., | 85 [1] |
| Victor, | Saville, Somes & Co., Boston, | 83 [1] |
| Victor, | Simpson Spring Co., South Easton, Mass., | 82 [1] |
| Pentucket, | Saville, Somes & Co., Boston, | 80 [1] |
| Adirondack Sugar, | Adirondack Sugar Company, Utica, N. Y., | 50 [2] |
| Pure Maple Cream, | Adirondack Sugar Company, Utica, N. Y., | 50 [2] |
| Pure Maple Cream, | Haskell, Adams & Co., Boston, | 50 [2] |
| - - | Ayer Preserving Company, Ayer, Mass., | 87 [1] |
| Rocky Ridge, | Rocky Ridge Maple Syrup Company, Boston, | 80 |

[1] Erroneous formula. [2] Cane sugar; no formula.

### *Meat Products.*

Special attention was paid to canned and preserved meats, with reference to their composition and to the presence of preservatives. A large part of this work, necessarily histological in character, was done by Dr. George B. Magrath. The following brands were condemued as adulterated: —

*Published Results of Analyses of Adulterated Brands of Canned Meats.*

| Character of Sample. | Brand, or Name of Manufacturer, Wholesaler or Producer. | Results of Analyses. |
|---|---|---|
| "Rex" Vienna sausage, . . | Cudahy Canning Company, Chicago, . | Preserved with a compound of boron. |
| "Rex" German lunch sausage, | Cudahy Canning Company, Chicago, . | Preserved with a compound of boron. |
| Canned corn beef, . . . | Oriental Packing Company, Abattoir No. 17. | Preserved with a compound of boron. |
| Canned ham, . . . . | Oriental Packing Company, Abattoir No. 17. | Preserved with a compound of boron. |
| Canned hamroll, . . . | Nelson, Morris & Co., Chicago, . . | Preserved with a compound of boron. |
| "Palace" lunch tongue, . . | Inter Ocean Packing Company, Abattoir No. 17. | Preserved with a compound of boron. |
| "Blue Ribbon" chipped beef, | German-American Provision Company, Chicago. | Preserved with a compound of boron. |
| "Veribest" ham loaf, . . | Armour & Co., Chicago, . . . | Preserved with a compound of boron. |
| "Veribest" sliced smoked beef, | Armour & Co., Chicago, . . . | Preserved with a compound of boron. |
| "Coin Special" chicken loaf, . | C. H. Hammond Co., Chicago, . . | Preserved with a compound of boron. |
| Chipped dried beef, . . . | Nelson Morris & Co., Chicago, . . | Preserved with a compound of boron. |
| Potted tongue, . . . . | Libby, McNeil & Libby, Chicago, . | Contained corn meal. |
| Potted tongue, . . . . | Van Camp Packing Company, Indianapolis, Ind. | Contained corn meal. |
| "Veribest" potted chicken, . | Armour & Co., Chicago, . . . | Contained corn meal. |
| Devilled chicken, . . . | Libby, McNeil & Libby, Chicago, . | Contained corn meal. |
| Devilled turkey, . . . | Libby, McNeil & Libby, Chicago, . | Contained corn meal. |
| "Veribest" devilled ham, . | Armour & Co., Chicago, . . . | Contained much corn meal. |
| "Rex" devilled ham. "The taste tells." | Cudahy Canning Company, Chicago, . | Contained kidney and corn meal. |
| Devilled ham, . . . . | Jacob Dold Packing Company, Buffalo, N. Y. | Contained corn meal. |
| "Lawson Pink" devilled ham, | Roger I. Sherman Co., Boston, . . | Contained a boron preservative. |
| "Eureka" devilled ham, . . | Ottumwa Packing Company, Abattoir No. 17, U. S. A. | Contained a boron preservative and corn meal. |
| Devilled ham, . . . . | Potter & Wrightington, Boston, . . | Contained a boron preservative. |
| "Advanced Brand" devilled ham. | Schwarzschild & Sulzberger, Chicago, | Contained a boron preservative. |
| "Veribest" potted ox tongue, | Armour & Co., Chicago, . . . | Contained much corn meal and salivary gland. |
| Potted ham, . . . . | Jacob Dold Packing Company, Buffalo, N. Y. | Contained corn meal. |
| Boned chicken, . . . . | Van Camp Packing Company, Indianapolis, Ind. | Contained a boron preservative. |
| Potted ham, . . . . | Columbian Conserve Company, Indianapolis, Ind. | Contained corn meal and a boron preservative. |
| "Veribest" potted ham, . . | Armour & Co., Chicago, . . . | Contained a compound of boron. |
| "Iowa's Pride" potted ham, . | John Morell & Co., Ottumwa, Ia., . . | Contained a compound of boron. |

## *Non-alcoholic Beverages.*

Samples of temperance drinks were examined for preservatives, and the following were condemned as adulterated: Ginger Champagne, the product of the Boonville Mineral Springs Company, Boonville, N. Y., and Ginger Wine, made by J. P. W. von Laer; both found to contain salicylic acid.

### *Pickles.*

Four samples of pickles, including "The Crubro Conserved Sweet and Mixed Pickles," manufactured by Cruikshank Bros. Co. of Pittsburg, Pa., were found to be adulterated with benzoic acid, used as a preservative.

### *Salad Dressings.*

The following brands of salad dressing were found to be adulterated: "Royal," made by the Horton-Cato Manufacturing Company, Detroit, Mich.; "Sniders," by T. A. Sniders Preserve Company, Cincinnati, O.; "Campbells," by the Joseph Campbell Company, Camden, N. J., were all found to be preserved with benzoic acid. The "Yacht Club" salad dressing, manufactured by Tildesley & Co., Chicago, Ill., was found to be preserved with boric acid. One sample of mayonnaise "made from pure Lucca," the product of R. S. Fielding Company of Haverhill, had for a basis cotton-seed oil instead of pure Lucca.

### *Salt.*

Two samples were found to be adulterated by the admixture of calcium carbonate.

### *Shrimps.*

Six of the 7 samples examined were found to be preserved with boric acid.

### *Spices.*

*Adulterated Brands of Spices.*

| Spice. | Brand. | Manufacturer or Wholesaler. | Result of Analysis. |
|---|---|---|---|
| Cloves, | Gold Medal, | Eastern Tea and Coffee Company, Boston. | Clove stems and exhausted cloves. |
| Cloves, | Challenge, | Importers' Tea and Coffee Company, Boston. | Chiefly stems. |
| Cloves, | - | B. Fisher & Co., New York, | Admixture of stems. |
| Mace, | Hatchet, | Twitchell, Champlin Company, Portland, Me. | Large admixture of wild mace. |
| Mace, | - | B. Fisher & Co., New York, | Large admixture of wild mace. |
| Mace, | Royal Standard, | Knickerbocker Milk Company, New York. | Large admixture of wild mace. |
| Mustard, | - | B. Fisher & Co., New York, | Admixture of turmeric. |
| Mustard, | - | Mills Tea and Butter Company, North Adams. | Admixture of turmeric. |
| Mustard, | - | Berry, Dodge & Co., Newburyport, | Admixture of wild seeds. |

### *Syrup.*

Under this heading are included a number of preparations forming the basis for summer beverages, mainly fruit syrups used in soda fountains. "True Fruit Raspberry Shrub," made by J. Hungerford Smith Company, Rochester, N. Y., was found to be preserved with benzoic acid.

### *Table Sauce.*

Of 62 samples of these preparations examined, 23 were found to be adulterated. The following brands were condemned: —

*Published results of Analyses of Table Sauces.*

| Brand. | Dealer or Manufacturer. | Result of Analysis. |
|---|---|---|
| Worcestershire, | Lea & Perrins, Worcester, Eng., and New York. | Contains salicylic acid. |
| Worcestershire, | Lancashire Preserving Company, Liverpool, Eng. | Contains salicylic acid. |
| Westminster Sauce, | T. T. Grossmith, London; Alart & McGuire, agents, U. S. A. | Contains benzoic acid. |
| Imperial Tomato Ketchup, | Winsor Fruit Company, West Virginia, | Contains benzoic acid. |
| Bordeaux Tomato Ketchup, | Standard Packing Company, Indianapolis, Ind. | Contains benzoic acid. |
| Middlesex Tomato Ketchup, | F. M. Bill & Co., Lowell, | Contains benzoic acid. |
| Hazel Brand Chili Sauce, | Henry Siegel Company, Boston, | Contains benzoic acid. |
| Hazel Brand Tomato Catsup. | Henry Siegel Company, Boston, | Contains benzoic acid. |
| Cruikshank's Chili Sauce, | Cruikshank Bros., Allegheny, Pa., | Contains benzoic acid. |
| Gem Tomato Ketchup, | Mrs. Bradley, Odessa, Del., | Contains benzoic acid. |
| Sunnyside Chili Sauce, | Tip Top Ketchup Company, Cincinnati, O., | Contains benzoic acid. |
| "Royal" Tartar Sauce, | Horton Cate Company, Detroit, Mich., | Contains benzoic acid. |

### *Vinegar.*

Fifty-four of 201 samples of vinegar were found to be adulterated. The table which follows gives the analytical data of samples of cider vinegar found to be below the standard, arranged in the order of their acidity. These samples were all undoubtedly made exclusively from apple stock, but failed to conform to the standard,

*Cider Vinegar below Standard.*

| Acetic Acid (Per Cent.). | Solids (Per Cent.). | Ash (Per Cent.). | Alkalinity of Ash.[1] | Polarization Degrees (Ventzke 200 mm. Tube). | Lead Acetate (ppt. c.c.'s). | Color. | Remarks. |
|---|---|---|---|---|---|---|---|
| 6.45 | 1.43 | 0.27 | 31.2 | —0.9 | 0.38 | Natural. | |
| 5.50 | 1.54 | 0.26 | - | —0.8 | 0.48 | Natural. | |
| 5.20 | 1.42 | 0.32 | - | —1.0 | 0.75 | Natural. | |
| 5.12 | 1.72 | 0.22 | - | —0.2 | 0.66 | Natural. | |
| 5.06 | 1.78 | 0.24 | - | —1.3 | 0.68 | Natural. | |
| 5.04 | 1.76 | 0.29 | 32.7 | —0.7 | 0.55 | Natural. | |
| 4.96 | 1.90 | 0.30 | - | —1.1 | 0.50 | Natural. | |
| 4.88 | 1.80 | 0.30 | - | —2.7 | 0.70 | Natural. | |
| 4.82 | 1.76 | 0.27 | - | —1.1 | 0.78 | Natural. | |
| 4.82 | 1.76 | 0.26 | - | —1.4 | 0.76 | Natural. | |
| 4.78 | 1.80 | 0.22 | 22.2 | —2.8 | 0.50 | Natural. | |
| 4.70 | 1.56 | 0.29 | - | —1.1 | 0.62 | Natural. | |
| 4.60 | 1.90 | 0.28 | - | —1.2 | 1.00 | Natural. | |
| 4.58 | 1.77 | 0.28 | 25.9 | —1.1 | 0.65 | Natural. | |
| 4.50 | 1.88 | 0.28 | - | —1.0 | 0.55 | Natural. | |
| 4.50 | 1.77 | 0.20 | - | —1.1 | 0.66 | Natural. | |
| 4.48 | 1.96 | 0.15 | 30.3 | —1.7 | 0.65 | Natural. | |
| 4.44 | 2.41 | 0.18 | - | —2.7 | 0.50 | Natural. | |
| 4.42 | 1.56 | 0.30 | 28.8 | —0.7 | 1.20 | Natural. | |
| 4.40 | 2.32 | 0.17 | - | —2.8 | 0.75 | Natural. | |
| 4.38 | 2.20 | 0.28 | - | —1.8 | 1.18 | Natural. | |
| 4.32 | 1.85 | 0.30 | - | —1.0 | 0.60 | Natural. | |
| 4.28 | 2.48 | 0.38 | - | —1.8 | 0.82 | Natural. | |
| 4.27 | 2.46 | 0.16 | - | —2.3 | 1.10 | Natural. | |
| 4.26 | 2.22 | 0.32 | - | —0.7 | 1.90 | Natural. | |
| 4.22 | 2.60 | 0.40 | - | —0.7 | 1.00 | Natural. | |
| 4.20 | 3.36 | 0.30 | 31.7 | —3.1 | 1.15 | Natural. | |
| 4.12 | 2.62 | 0.20 | - | —1.0 | 0.40 | Natural. | |
| 4.02 | 1.54 | 0.35 | - | —1.1 | 0.48 | Natural. | |
| 4.00 | 2.31 | 0.28 | - | —1.2 | 0.57 | Natural. | |
| 3.86 | 2.38 | 0.49 | - | —0.3 | 0.68 | Natural. | |
| 3.64 | 2.00 | 0.30 | - | —0.6 | 0.84 | Natural. | |
| 3.60 | 1.28 | 0.29 | 30.9 | —0.9 | 0.52 | Natural. | |
| 3.46 | 2.33 | 0.34 | - | —2.0 | 1.20 | Natural. | 2.50 per cent. alcohol. |
| 3.25 | 1.31 | 0.15 | 30.6 | —0.6 | 0.90 | Natural. | |
| 2.51 | 2.88 | 0.21 | 15.2 | —3.6 | 0.75 | Natural. | 2.17 per cent. alcohol. |

[1] Phenolphthalein used as indicator.

The following table shows similar data in regard to samples sold for cider vinegar, and which were not exclusively the product of cider: —

*Vinegar not made exclusively from Pure Apple Cider.*

| Acetic Acid (Per Cent.). | Solids (Per Cent.) | Ash (Per Cent.). | Polarization in 200 mm. Tube (Ventzke Scale). | Lead Acetate (ppt. c.c.'s). | Color. |
|---|---|---|---|---|---|
| 5.34 | 1.64 | 0.09 | —0.6 | 0.50 | Caramel. |
| 5.16 | 0.75 | 0.14 | +0.5 | 0.40 | Caramel. |
| 5.04 | 0.83 | 0.15 | +0.4 | 0.40 | Caramel. |
| 4.96 | 2.29 | 0.20 | —3.2 | 0.58 | Caramel. |
| 4.88 | 2.49 | 0.32 | —3.0 | 1.57 | Caramel. |
| 4.88 | 0.24 | 0.04 | +0.2 | 0.60 | Caramel. |
| 4.74 | 0.26 | 0.04 | +0.6 | trace | Caramel. |
| 4.58 | 1.96 | 0.32 | —1.6 | 0.85 | Caramel. |
| 4.58 | 0.31 | 0.07 | +0.8 | - | Caramel. |
| 4.56 | 0.81 | 0.05 | +1.0 | 0.10 | Caramel. |
| 4.56 | 0.66 | 0.04 | +1.0 | 0.02 | Caramel. |
| 4.54 | 2.02 | 0.26 | +0.4 | 0.70 | Caramel. |
| 4.54 | 1.47 | 0.40 | +0.4 | 0.15 | Caramel. |
| 4.52 | 0.29 | 0.04 | +0.6 | - | Caramel. |
| 4.50 | 2.12 | 0.06 | —1.4 | 0.50 | Caramel. |
| 4.50 | 0.37 | 0.06 | +0.8 | - | Caramel. |
| 4.34 | 1.10 | 0.09 | +0.4 | - | Caramel. |
| 3.84 | 0.29 | 0.04 | +0.8 | 0.15 | Caramel. |

The quantitative determination of the precipitate formed with lead acetate or sub-acetate has been found to be of considerable importance. The value of this test made qualitatively has for many years been appreciated. Even though the precipitate formed with lead acetate may not be due, as was long thought, to malic acid, but may be largely due to phosphoric acid (though this has not been fully proved), it nevertheless remains a fact that the qualitative test is one of the most important of all, and that unless a characteristic precipitate comes down with the lead salt, a sample may always be condemned as not being pure cider vinegar.

The quantity of the lead precipitate has been measured in much the same way as is recommended by Hortvet for maple syrup in circular 23 of the Bureau of Chemistry. To 25 cubic centimeters of the vinegar, add 2.5 cubic centimeters of U. S. P. sub-acetate of lead solution; shake and whirl in a graduated Hortvet tube in the centrifugal machine, and read the volume of the precipitate in the bottom of the tube. This constant, expressed in cubic centimeters, is given in the above tables, and it will be

seen to be of considerable importance, taken in connection with other data. It is not yet practicable to set a minimum figure for the lead acetate precipitate of pure cider vinegar.

In determining the lead acetate number according to the above method, one pours off the clear solution from which the lead precipitate has settled, and uses this for the polarization, adding one-tenth to the reading to compensate for the dilution.

Another constant, which will undoubtedly prove to be of great importance in determining the purity of vinegar, is the alkalinity of the ash. In determining this constant much depends upon the uniformity of the method employed, since very widely differing results are obtainable by the use of different methods, and especially of different indicators. H. C. Lythgoe of this laboratory has embodied the results of some work done in this direction in a separate paper following this report.

*Miscellaneous Foods.*

Samples of the following were examined and found free from adulteration: "Apple Jack," biscuit, malt extract, peanut butter, scallops and sugar.

A sample of "Coffee Finish," a liquid solution intended to improve the appearance of whole coffee beans, was found to depend largely for its efficiency on the presence of dextrin and caramel.

A sample of "liquid rennet," manufactured by James T. Shinn of Philadelphia, Pa., was found to contain boric acid.

An egg substitute known as the "Economic Wonder," sold by the Economic Powder Company of Providence, R. I., each package purporting to contain the equal of 36 fresh eggs, was found to consist largely of corn starch. By actual analysis it showed ether extract, 3.48 per cent.; alcohol extract, 6.13 per cent.; starch, 74.25 per cent.; proteids, 6.43 per cent.; moisture, 10.35 per cent., and ash, 0.85 per cent.

A new product has recently come to light, for sale by liquor dealers, for the alleged purpose of steadying the nerves and counteracting the effects of prolonged indulgence in alcoholic beverages. This is put up in large bottles, under various names, but in all cases the composition of the so-called "bracer" or "toner" is almost identical with that of tomato ketchup, containing besides the tomato pulp as a base red pepper and other spices, and generally a liberal dose of salicylic or benzoic acid as a preservative.

Three samples of this variety are listed among the adulterated foods examined during the year, as follows: —

"Tomato Flip, a bracer for a weak stomach, to be taken freely in large draughts." This was found to be preserved with both salicylic and benzoic acids.

"Tomato Toner, a hot one, assists over-worked stomachs caused from excesses of any kind." Found to contain much benzoic acid.

"Nerver, prepared for fine bar trade, a pure extract of tomato, particularly intended to soothe the nerves and regulate the stomach of all suffering from the effects of excessive drink. It is a great bracer after a 'hot night.'" Largely dosed with benzoic acid.

*Summary of Food Statistics, exclusive of Milk.*

| | Genuine. | Adulterated. | Total. | | Genuine. | Adulterated. | Total. |
|---|---|---|---|---|---|---|---|
| Baking powder, | 9 | - | 9 | Lard, | 92 | 5 | 97 |
| Butter, | 116 | 7 | 123 | Lime juice, | 1 | 5 | 6 |
| Cake, | 4 | - | 4 | Malt and barley, | 4 | 2 | 6 |
| Canned fruit and vegetables, | 35 | 6 | 41 | Malt liquors: — | | | |
| Cereal flours, | 14 | 1 | 15 | Ale, | 47 | 2 | 49 |
| Cheese, | 18 | - | 18 | Beer, | 38 | 22 | 60 |
| Cider, | 15 | 4 | 19 | Porter, | 16 | 1 | 17 |
| Clams, | 20 | - | 20 | Maple products, | 5 | 8 | 13 |
| Cocoa, | 33 | 2 | 35 | Maple sugar, | 22 | 9 | 31 |
| Cocoanut, | 17 | - | 17 | Maple syrup, | 21 | 21 | 42 |
| Coffee, | 28 | 1 | 29 | Meat products: — | | | |
| Coffee substitutes, | 2 | 2 | 4 | Bacon, | 2 | - | 2 |
| Condensed milk, | 17 | 8 | 25 | Blood pudding, | 3 | 1 | 4 |
| Confectionery, | 65 | 2 | 67 | Canned meats, | 186 | 45 | 231 |
| Cream, | 97 | 7 | 104 | Ham, | 43 | 26 | 69 |
| Cream of tartar, | 72 | 1 | 73 | Hamburg steak, | 3 | - | 3 |
| Dessert preparations, | 7 | - | 7 | Head cheese, | 31 | 6 | 37 |
| Evaporated cream, | - | 11 | 11 | Lambs' tongues, | 13 | 6 | 19 |
| Flavoring extracts: — | | | | Meat jellies, | 7 | 4 | 11 |
| Almond, | 4 | - | 4 | Mince meat, | 17 | 14 | 31 |
| Lemon, | 16 | 24 | 40 | Miscellaneous, | 6 | - | 6 |
| Pineapple, | 1 | - | 1 | Sausages, | 231 | 59 | 290 |
| Raspberry, | 1 | - | 1 | Tripe, | 15 | 9 | 24 |
| Strawberry, | 1 | 1 | 2 | Molasses, | 31 | - | 31 |
| Vanilla, | 40 | 11 | 51 | Non-alcoholic beverages, | 35 | 2 | 37 |
| Wintergreen, | - | 1 | 1 | Oysters, | 36 | - | 36 |
| Gluten, | - | 4 | 4 | Pickles, | 35 | 4 | 39 |
| Grape juice, | 24 | 4 | 28 | Salad dressing, | 24 | 6 | 30 |
| Honey, | 35 | - | 35 | Salt, | - | 2 | 2 |
| Jams and jellies, | 70 | 21 | 91 | Shrimps, | 1 | 6 | 7 |

*Summary of Food Statistics, exclusive of Milk* — Concluded.

| | Genuine. | Adulterated. | Total. | | Genuine. | Adulterated. | Total. |
|---|---|---|---|---|---|---|---|
| Spices: — | | | | Spices — *Con.* | | | |
| Allspice, | 16 | - | 16 | Pepper, | 62 | 2 | 64 |
| Cassia, | 29 | - | 29 | Syrups, | 6 | 1 | 7 |
| Cayenne, | 11 | - | 11 | Table sauces, | 39 | 23 | 62 |
| Cloves, | 29 | 3 | 32 | Tea, | 1 | - | 1 |
| Ginger, | 30 | 1 | 31 | Vinegar, | 144 | 57 | 201 |
| Mace, | 6 | 6 | 12 | Wine, | 3 | 2 | 5 |
| Mustard, | 42 | 9 | 51 | Miscellaneous, | 13 | 3 | 16 |
| Nutmeg, | 7 | - | 7 | Total, | 2,214 | 490 | 2,704 |

## Drugs.

The general scope and character of the drugs examined is shown in the summary on page 406. Only such drugs as for any reason call for special comment will be otherwise mentioned.

### *Alcohol.*

Among the ten samples of this drug classed as adulterated several were found bad enough for prosecution. The poorest sample contained only 48.43 per cent. of alcohol. Four others were found to stand below 80 per cent. Three samples, purchased for alcohol in paint shops, were found to consist of wood alcohol, without the required poison label. A sample of so-called chafing-dish alcohol was found to consist of wood alcohol, without the poison label, and was the subject of prosecution in Brockton.

### *Aqua Hamamelidis Spirituosa.*

A large number of samples of hamamelis were collected from drug stores throughout the State and examined for the presence of formaldehyde and of wood alcohol. Out of 235 samples analyzed, 24 were pronounced adulterated.

The following is a list of dealers from which the adulterated samples were purchased, together with the results of the analyses: —

*Published Results of Analyses of Adulterated Samples of Witch Hazel Extract.*

| | | |
|---|---|---|
| F. L. Woolworth, Boston, | 4.62 per cent. alcohol. | Contained formaldehyde. |
| Dr. Miner's Drug Store, Ware, | 10.00 per cent. alcohol. | Contained formaldehyde. |
| Hanover Drug Company, Boston, | 7.93 per cent. alcohol. | Contained formaldehyde. |
| Lloyd L. Walker, Lowell, | 8.50 per cent. alcohol. | Contained formaldehyde. |
| James O'Brien, Lowell, | 8.57 per cent. alcohol. | Contained formaldehyde. |
| Lyceum Hall Pharmacy, Brookline, | 9.86 per cent. alcohol. | Contained formaldehyde. |
| Dartmouth Drug Company, Boston, | 6.28 per cent. alcohol. | Contained formaldehyde. |
| McCarthy's Pharmacy, Boston, | 6.28 per cent. alcohol. | Contained formaldehyde. |
| J. P. Sisonsky, Boston, | 4.75 per cent. wood alcohol. | Contained formaldehyde. |
| Harvard Extract Company, Cambridgeport. | 9.00 per cent. wood alcohol. | Contained formaldehyde. |
| Frank E. Harris, Binghamton, N. Y., | 9.54 per cent. alcohol. | Contained formaldehyde. |
| C. S. Stearns, North Andover, | 10.00 per cent. alcohol. | Contained formaldehyde. |
| George H. Perkins, North Andover, | 9.04 per cent. alcohol. | Contained formaldehyde. |
| G. W. Russell, North Adams, | 7.00 per cent. alcohol. | Contained formaldehyde. |
| T. C. Farley, North Adams, | 10.92 per cent. alcohol. | Contained formaldehyde. |
| W. A. Little & Co., Boston, | 6.64 per cent. alcohol. | Contained formaldehyde. |
| Thomas B. Nichols, Salem, | 8.14 per cent. alcohol. | Contained formaldehyde. |
| Cleveland Pharmacy, Holyoke, | 9.57 per cent. alcohol. | Contained formaldehyde. |
| H. T. Matthewson, Brookfield, | 12.38 per cent. alcohol. | Contained formaldehyde. |
| Wm. B. Mahern, South Framingham, | 9.43 per cent. alcohol. | Contained formaldehyde. |
| Davis & Hatch Spice Company, New Bedford. | 7.93 per cent. alcohol. | Contained formaldehyde. |
| Charles L. Curtis, South Framingham, | 9.29 per cent. alcohol. | Contained formaldehyde. |

In testing for formaldehyde, all samples were first subjected to a qualitative test by adding a few drops of the original sample to some milk previously found to be free from formaldehyde, and applying the regular hydrochloric acid and ferric chloride test. If formaldehyde was indicated, the confirmatory test was made in the regular manner by distillation, testing the distillate. The amount of formaldehyde was determined in all samples found to contain it by the hydrogen peroxide method of Blank and Finkenbeiner.[1] The amount found present varied from 0.06 to 0.25 per cent. Since, as a rule, commercial wood alcohol contains traces of formaldehyde, those samples which were found to contain formaldehyde were further examined for wood alcohol by the following method: to 55 cubic centimeters of the sample 10 grams of sodium bisulphite were added, and the mixture allowed to stand for two hours. Under this treatment, as a rule, the formaldehyde was used up. The mixture

[1] Berichte, 31, p. 2979; Bur. of Chem., Bul. 62, p. 142.

was next distilled, and the distillate a second time treated with an excess of sodium hydroxide, to remove the sulphurous acid. The second distillate, free from formaldehyde and from sulphites, was then examined in the usual manner for wood alcohol by the refractometric method. Two samples were found to contain respectively 4.75 and 9 per cent. of wood alcohol.

### *Calx Chlorata.*

One new brand examined this year was found to contain 74 per cent. of the required strength. This was the product of Larkin of Buffalo, N. Y.

### *Capsicum.*

A marked improvement is shown of late in the quality of powdered red pepper as sold in the drug stores. Only 2 samples were found to be adulterated with the usual admixture of corn or wheat starch.

The apparent reason why red pepper and other spices purchased from drug stores was formerly found to be of much lower grade than that purchased of grocers is the fact that in nearly every case druggists purchased their spices in bulk, with no reputable manufacturer's name as a guarantee on the package, a practice which no careful grocer would follow.

### *Liquor Formaldehydi.*

Fifty-four samples were examined, all but 1 of which were found to contain from 36 to 40 per cent. of formaldehyde. The sample classed as adulterated contained but 29.68 per cent. Formaldehyde was determined by means of the immersion refractometer.

### *Methyl Alcohol.*

All samples of wood alcohol, purchased as such, were found to be properly marked with the poison label in accordance with the law.

### *Oleum Olivæ.*

The ratio of adulteration of olive oil is still high. While cotton-seed oil is, as formerly, the favorite adulterant, 3 samples were this year found to contain large admixtures of sesame oil. The worst sample contained as high as 80 per cent. of this adulterant.

The following is a list of dealers from whom adulterated brands were purchased, together with the result of the analyses: —

*Published Results of Analyses of Olive Oil.*

| | |
|---|---|
| Thompson Pharmacy, Adams, | Largely cotton-seed oil. |
| Alfred Robinson, Fall River, | Cotton-seed oil. |
| Kimball & Co., Everett, | Cotton-seed oil. |
| B. F. Bradbury, Boston, | Cotton-seed oil. |
| J. F. O'Donnell, Cambridge, | Cotton-seed oil. |
| D. Amones & Co., Boston, | Cotton-seed oil. |
| J. W. Patch & Co., Boston, | Cotton-seed oil. |
| Dunbar's Drug Store, Taunton, | Cotton-seed oil. |
| R. E. Willard & Son, Pittsfield, | Cotton-seed oil. |
| Walter A. Dewire, Pittsfield, | Cotton-seed oil. |
| J. M. Nelson, Lynn, | Cotton-seed oil. |
| Theodore Metcalf Company, Boston, | Large admixture of cotton-seed oil. |
| Copley Square Pharmacy, Boston, | Large admixture of sesame oil. |
| Albert W. Kidder, Cambridge, | Large admixture of cotton-seed oil. |
| Arthur L. Green, Boston, | Large admixture of cotton-seed oil. |
| Davis & Young, Lynn, | Cotton-seed oil. |
| J. H. Beauvais, Springfield, | Cotton-seed oil. |
| G. W. Russell & Co., North Adams, | 80 per cent. sesame oil. |
| Henry Arsenault, Athol, | 40 per cent. sesame oil. |
| Geo. G. Leathe, Gardner, | Cotton-seed oil. |
| Fourth St. Pharmacy, South Boston, | Cotton-seed oil. |

### *Sodii Boras.*

One brand labeled "Smith's Powdered Bicarbonate Borax," sold by T. L. Woolworth of Boston, was found to consist entirely of sodium bicarbonate and to contain no borax at all. The "Crescent" brand of borax, sold by Charles L. Hirsch & Co. of New York, also consisted entirely of sodium bicarbonate.

### *Spiritus Camphoræ.*

A number of samples of spirits of camphor were found to vary considerably from the pharmacopœial standard. All samples were examined by the polariscope and refractometer. Three cases published during the year were the following: —

*Published Results of Analysis of Spirits of Camphor.*

| | |
|---|---|
| Geo. G. Leathe, Gardner, | 35 per cent. of the required strength. |
| Wilson House Drug Store, North Adams, | 50 per cent. of the required strength. |
| C. A. Pinsonhault, North Adams, | 45 per cent. of the required strength. |

### *Spiritus Frumenti.*

In spite of the fact that two-thirds of the whiskey samples purchased from drug stores were found not to conform to the standard of the Pharmacopœia, even this showing is an improvement over past years. Druggists are gradually becoming alive to the fact that they are expected to sell whiskey of at least as good a grade as that dispensed in saloons.

### *Spiritus Vini Gallici.*

All samples examined were found to be below the standard, being artificially colored in all cases, and having residues consisting largely of sugar.

### *Tinctura Iodi.*

The quality of tincture of iodine as sold to-day in the average drug store is far higher than formerly. While nearly a third of the samples examined failed to conform to the standard of the Pharmacopœia, all but 3 stood so near the required strength as to be fairly satisfactory; in fact, the average strength of all samples examined during the period of this report is well above 90 per cent. of that required by the Pharmacopœia. The 5 worst cases were the following: —

*Published Results of Analyses of Tincture of Iodine.*

| | |
|---|---|
| Broadway Pharmacy, Everett, | 12 per cent. of the United States Pharmacopœia strength. |
| Geo. H. Malley, Forest Hills, | 8.2 per cent. of the United States Pharmacopœia strength. |
| H. P. Elsey, Springfield, | 68 per cent. of the United States Pharmacopœia strength. |
| ——— Richards, Springfield, | 65 per cent. of the United States Pharmacopœia strength. |
| Benj. F. Bradbury, Boston, | 49 per cent. of the United States Pharmacopœia strength. |

### *Proprietary Preparations.*

Under this heading are included a large variety of "patent" remedies.

*Bromo Seltzer, Emerson's.* — This preparation was found to contain potassium bromide, sodium bicarbonate, tartaric acid, citric acid and acetanilid.

*Catarrh Remedies.* — Sixty-seven samples of various proprietary remedies for catarrh, asthma, colds, etc., were examined, of which 18 were found to contain cocaine. Under chapter 386 of the Acts of 1906 dealers selling such preparations containing cocaine, without the written prescription of a physician, do so unlawfully. The following preparations were found to contain cocaine: —

*Published Results of Analyses of Catarrh Remedies.*

| | |
|---|---|
| Dr. Agnew's. Anglo American Medicine Company, Chicago, . . . | Contained cocaine. |
| Crown. Crown Catarrh Powder Company, New York, . . . . . . | Contained cocaine. |
| Instant Catarrh Relief. I. C. R. Medicine Company, Boston, . . . | Contained cocaine. |
| Prentzinger's Catarrh Balm. R. Prentzinger & Bro., Dayton, O.,. . . | Contained cocaine. |
| Dr. Cole's Catarrh Cure. The Cole Medicine Company, London, N.Y., . | Contained cocaine. |
| Specific for asthma, hay fever and all catarrhal diseases of the respiratory organs. Nathan Tucker, M.D., Mt. Gilead, O. | Contained cocaine. |
| The Allenbury's Throat Pastilles, Allen & Hanburys, Ltd., London, . . | Contained cocaine. |

In examining powdered preparations for presence of cocaine the sample is treated with water, acidified with acetic acid and filtered. The filtrate is then made ammoniacal and extracted with benzol, the residue from the benzol being examined for the presence of cocaine.

*"Chevalla."* — A rheumatism cure, was found to contain morphine, potassium iodine and 50 per cent. by volume of alcohol.

*Dr. Arnold's Cough Killer.* — This preparation contained 11½ per cent. of alcohol by volume.

*Dr. Shoop's Restorative.* — This contained 11.96 per cent. by volume of alcohol.

*Electric Bitters.* — This was found to contain 18.48 per cent. by volume of alcohol.

*Essenza di China China.* — This preparation contained 34.6 per cent. by volume of alcohol.

*Headache Powders.* — Half a dozen samples of these preparations were examined, and all were found to contain acetanilid.

*Herbal Dew.* — "A positive cure for asthma, hay fever, etc." This was sold by the Brenner Extract Company of Boston. It contained 51.01 per cent. of alcohol by volume; in fact, its basis was rum, containing a bitter non-alkaloidal principle.

*Hood's Sarsaparilla.* — This contained 17.92 per cent. by volume of alcohol.

*Hostetter's Stomach Bitters.* — This was found to contain 43.75 per cent. of alcohol by volume.

*Kingsbury's Freckle Remover.* — Found to contain corrosive sublimate; prepared by W. T. & J. S. Kingsbury of Randolph.

*Liquor Adulterants.* — Under this head were included several high-priced preparations for the manufacture of distilled liquors. These were sold under the names of "Wiscoline," "Wiscol," "Brandol" and "Jamaica Rum Essence." They were all made up of artificial fruit essences, chiefly fusel oil derivatives, colored with caramel.

*Paine's Celery Compound.* — Containing 19.96 per cent. alcohol by volume.

*Peruna.* — This was found to contain 23.18 per cent. of alcohol by volume.

*"Phenoid Paste."* — A paint and varnish remover.

*Swift's Specific.* — Containing 16.07 per cent. by volume of alcohol.

*Vegetable Hair Tonic.* — Found to contain a lead salt.

*White Ribbon Remedy for Alcoholism.* — This was found to consist of 8.02 per cent. of ammonium chloride and 91.98 per cent. of milk sugar.

*Miscellaneous.* — Twelve preparations, chiefly negative in character.

***Summary of Drug Statistics.***

| | Genuine. | Adulterated. | Total. | | Genuine. | Adulterated. | Total. |
|---|---|---|---|---|---|---|---|
| Æther, | 1 | 1 | 2 | Oleum carophylli, | 6 | - | 6 |
| Alcohol, | 20 | 10 | 30 | Oleum cinnamomi, | 7 | - | 7 |
| Aqua ammonia, | 4 | 2 | 6 | Oleum limonis, | 13 | 4 | 17 |
| Aqua ammonia fortis, | 6 | 1 | 7 | Oleum morrhuæ, | 5 | - | 5 |
| Aqua distillata, | 1 | - | 1 | Oleum olivæ, | 149 | 23 | 172 |
| Aqua hamamelidis spirituosa, | 211 | 24 | 235 | Oleum ricini, | 18 | 1 | 19 |
| Calcis carbonas precipitatum, | 2 | - | 2 | Opii pulvis, | 1 | 2 | 3 |
| Calx chlorata, | 2 | 3 | 5 | Proprietary preparations, | 69 | 18 | 87 |
| Capsicum, | 44 | 2 | 46 | Santonin, | 1 | - | 1 |
| Cera alba, | 3 | 5 | 8 | Sodii boras, | 6 | 2 | 8 |
| Cera flava, | 13 | 5 | 18 | Sodii phosphas, | 6 | - | 6 |
| Cetaceum, | 2 | - | 2 | Spiritus camphoræ, | 65 | 19 | 84 |
| Chloroformum, | 5 | - | 5 | Spiritus frumenti, | 6 | 10 | 16 |
| Cinnamomum cassia, | 1 | - | 1 | Spiritus menthæ piperitæ, | 10 | 2 | 12 |
| Extractum glycyrrhizæ, | 2 | 5 | 7 | Spiritus vini gallici, | - | 7 | 7 |
| Ferri et quininæ citras, | 1 | - | 1 | Sulphur lotum, | 3 | - | 3 |
| Fluid extractum zingiberis, | 5 | 13 | 18 | Sulphur precipitatum, | 1 | - | 1 |
| Glycerinum, | 44 | - | 44 | Syrupus, | - | 1 | 1 |
| Liquor formaldehyde, | 53 | 1 | 54 | Tinctura iodi, | 165 | 64 | 229 |
| Magnesi sulphas, | 1 | - | 1 | Tinctura opii camphorata, | 3 | - | 3 |
| Methyl alcohol, | 6 | - | 6 | Tinctura rhei, | 4 | 1 | 5 |
| Miscellaneous, | 21 | 5 | 26 | Tinctura zingiberis, | 4 | 1 | 5 |
| Oleum amygdalæ dulcis, | - | 1 | 1 | Total, | 990 | 223 | 1,223 |

*General Summary.*

| | Genuine. | Adulterated or below Standard. | Total. |
|---|---|---|---|
| Milk, | 2,316 | 1,287 | 3,603 |
| Foods exclusive of milk, | 2,214 | 490 | 2,704 |
| Drugs, | 990 | 233 | 1,223 |
| Total, | 5,520 | 2,010 | 7,530 |

## Kerosene Oil.

Numerous samples of kerosene oil were collected and examined for their flash point, under chapter 102, section 106, of the Revised Laws, which requires that petroleum illuminating oil to be sold legally must not evaporate a gas under 100° F.

Twelve samples purchased in Plymouth were found to flash between 95° and 96°. The flash point was determined by means of a standard Tagliabue oil tester.

## Inspection of Liquors.

Samples of liquors were sent in for the determination of alcohol by officers of 31 towns and cities. The following table shows the character of the samples examined: —

*Summary of Liquor Statistics.*

| Cities and Towns. | Number of Samples of Wine. | Number of Samples of Cider. | Number of Samples of Beer. | Number of Samples of Whiskey. | Number of Samples of Alcohol. | Number and Character of Miscellaneous Samples. |
|---|---|---|---|---|---|---|
| Arlington, | - | 1 | - | - | - | |
| Ashland, | - | - | 1 | - | - | |
| Avon, | - | - | - | 1 | 2 | |
| Boston, | 1 | - | - | 1 | - | 1, essence of whiskey; 2, essences of rum; 1, orange bitters. |
| Braintree, | - | - | 1 | - | - | |
| Brockton, | - | - | - | - | 10 | |
| Cambridge, | 2 | - | 1 | - | - | |
| Cottage City, | 1 | - | - | - | - | 1, cherry rum. |
| Danvers, | - | 2 | - | - | - | |
| East Bridgewater, | - | - | - | - | - | 1, ginger ale. |
| Falmouth, | 1 | - | - | - | - | |

*Summary of Liquor Statistics* — Concluded.

| Cities and Towns. | Number of Samples of Wine. | Number of Samples of Cider. | Number of Samples of Beer. | Number of Samples of Whiskey. | Number of Samples of Alcohol. | Number and Character of Miscellaneous Samples. |
|---|---|---|---|---|---|---|
| Fitchburg, | 3 | 1 | 13 | 1 | - | 3, "champagne ciders"; 1, "Slivervitz" liquor, a Grecian drink. |
| Foxborough, | - | 1 | - | - | - | |
| Franklin, | - | 1 | - | 1 | - | |
| Haverhill, | - | - | - | 1 | - | 2, gins. |
| Hyde Park, | - | - | - | - | - | 12, "Jamaica gingers." |
| Leominster, | - | 7 | 1 | - | - | |
| Maynard, | - | 4 | 4 | - | - | |
| Newton, | - | - | - | - | - | 2, "malt extracts." |
| North Attleborough, | - | 1 | - | - | - | 1, "Jamaica ginger." |
| Norwood, | 1 | - | - | - | - | 1, "Thielman's droppar," contains essential oil similar to peppermint; 1, "Jamaica ginger." |
| Peabody, | - | 1 | - | - | - | |
| Revere, | - | - | 5 | - | - | |
| Salem, | 1 | - | - | - | - | 2, "malt extracts." |
| Southbridge, | - | - | - | 1 | - | |
| Stoughton, | - | 2 | - | 1 | 1 | 1, gin. |
| Quincy, | - | 3 | - | 1 | - | 1, "malt extract"; 2, brandies. |
| Randolph, | - | - | - | 2 | - | |
| Waltham, | - | 4 | 1 | - | - | |
| Wellesley, | 1 | 1 | - | - | - | |
| Westminster, | - | - | 2 | - | - | |
| Total, | 11 | 29 | 29 | 10 | 13 | 33 |

The majority of these samples figured in court cases, but in most instances the certificate of analysis was used in evidence. Attendance of the chemist was necessary in the lower courts of Boston, Concord, Salem and Waltham, and in the superior court of Suffolk County.

Among the preparations brought in by liquor officers was a so-called essence of rum seized in Boston from an Italian druggist. This purported to be sold as a simple flavoring essence, but was found to be similar in character to the regular liquor adulterants. It was labeled "Essenza di Rhum Inglese," and was contained in five small bottles. Analytical data on this preparation are as follows: solids, 1.89 per cent.; ash, 0.06 per cent.; mineral or organic acid, 0.0 per cent.; fusel oil, 9.02 per cent.; alcohol, 71.67 per cent.; water, 17.18 per cent.

A number of "malt extracts" were also included, which were found to contain about the same amount of alcohol as ordinary beer, and to have none of the diastatic powers characteristic of genuine malt.

Another favorite beverage was the so-called Jamaica ginger, 12 samples of which were seized in Hyde Park. These preparations contained from 18 to 48 per cent. of alcohol by volume, and were for the most part contained in what are commonly known as picnic flasks, being sold obviously as a beverage and not for use as a medicine.

Respectfully submitted,

ALBERT E. LEACH.

# A COMPARISON OF METHODS

FOR THE

# DETERMINATION OF THE ALKALINITY OF ASH.

By HERMANN C. LYTHGOE.

# A COMPARISON OF METHODS FOR THE DETERMINATION OF ALKALINITY OF ASH.

By Hermann C. Lythgoe.

The alkalinity of ash is recognized as an important constant in determining the purity of many food products, but unfortunately there is but little uniformity in the procedure, and consequently varied results are reported by different analysts on the same class of substances.

The work here outlined, which is not yet completed, was undertaken with a view of securing uniformity and of arriving at a method which will give as nearly as possible the true alkalinity.

The methods employed are as follows: —

One hundred grams of the sample were evaporated to dryness in a platinum dish and burned in a muffle. The ash was treated with cold water, rubbed well with a piece of rubber on the end of a glass rod, and washed upon a filter with cold water. If any carbon remained the filter was placed in a dish and burned, the ash treated as above, and washed until the combined filtrate measured 200 cubic centimeters. In the second method the ash was treated in the same way with boiling water, and in its third method it was boiled for five minutes with 50 cubic centimeters of water before filtering and washing.

The resulting solutions were titrated with $\frac{N}{10}$ sulphuric acid, using phenolphthalein, methyl-orange, cochineal and litmus as the indicators. When using phenolphthalein, an excess of acid was added, the solution was boiled until the carbon dioxide was expelled and the excess of acid determined by titrating with $\frac{N}{10}$ alkali.

The following are the results obtained on one sample each of vinegar, lime juice and raspberry syrup: —

*Alkalinity of Ash.*

[Cubic centimeters $\frac{N}{10}$ acid required to neutralize the soluble ash of 100 grams of substance.]

| Character of Sample. | Method. | Indicator. | | | |
|---|---|---|---|---|---|
| | | Phenolphthalein. | Methyl Orange. | Cochineal. | Litmus. |
| Vinegar, | 1 | 33.1 | 40.9 | 37.9 | 24.9 |
| Vinegar, | 2 | 32.9 | 41.1 | 38.8 | 24.6 |
| Vinegar, | 3 | 34.0 | 40.9 | 39.1 | 24.9 |
| Lime juice, | 1 | 15.8 | 18.8 | 17.5 | 12.2 |
| Raspberry syrup, | 1 | 15.5 | 20.3 | 17.1 | 11.0 |

These varying results are no doubt caused by the phosphate present, as the following experiments show. Solutions of 0.25 gram of sodium phosphate in 150 cubic centimeters of water were titrated with $\frac{N}{10}$ acid, and required for neutralization 0.65 cubic centimeters when phenolphthalein was used, 9.20 cubic centimeters with methyl-orange, 8.70 cubic centimeters with cochineal and about 2 cubic centimeters with litmus, there being considerable difficulty in getting an end point with the latter indicator in the presence of such a large quantity of phosphate.

It would seem from the above experiment that phenolphthalein gives more nearly the correct figure.

# INSPECTION OF DAIRIES.

By the Secretary of the Board.

# INSPECTION OF DAIRIES.

By the Secretary of the Board.

During the fourteen months ended Nov. 30, 1906, 3,421 dairies have been examined by the veterinarian employed by the Board for this purpose, and the attention of 2,357 proprietors has been called by letter to a total of 8,822 objectionable conditions, the great majority of which were of such a nature as to be susceptible of correction at little or no expense. In each instance the producer was advised as to what changes were deemed necessary in the interest of a wholesome milk supply, with the information that, if the suggestions were disregarded, it would become necessary to take steps to cause his product to be excluded from public sale. At the same time, the local health authorities of the city or town wherein the milk was being produced or sold were notified, and they were requested to lend their assistance in securing improved conditions; and if the milk were being handled by contracting concerns, similar letters were sent thereto.

The results of the communications, while not all that could be wished, have been very encouraging. The great majority of the producers who have sent replies have shown a commendable desire to do all in their power to bring about improvement; many have expressed their thanks for the suggestions, and more have acknowledged having been careless in the matter of general cleanliness and proper handling, and have announced their determination never again to be subject to criticism in any particular. The attitude of many local authorities in this most important movement for the reduction of infantile mortality has been most gratifying; they or their agents have made personal investigation of the dairies brought to their notice, and have caused owners disinclined to improve their premises or methods either to comply with the suggestions or to cease selling within their respective jurisdictions. In order to be able to exclude from sale the milk of insanitary dairies, they have established regulations under their general authority to conserve the public health, and have enforced the same. It is a regrettable fact, however, that not a few local authorities have evinced a total lack of interest in the improvement of the milk supply, and some have even manifested a hostile spirit.

As a rule, the large dealers have co-operated in the movement for cleaner milk; they have sent veterinarians or other agents to visit the farms from which they draw their supply, and have refused to continue their contracts with those whose premises have been found to be kept in such condition or whose habits and methods were such as to be incompatible with the obtaining of a wholesome product.

The following table shows the number of dairies examined in the cities and towns visited, and the percentage found in each place to be free from objectionable conditions. It is proper to remark that the returns from the places visited during the warmer months would have been less favorable in many instances, since the cows, being out at pasture during the greater part of the working day, could not be examined as to their condition of cleanliness or of health.

It will be noted that not all the dairies inspected were situated in Massachusetts. In examining the sources of the supply of Springfield, it was found necessary to go over the line into Connecticut, to inspect the cows and premises of 154 producers, only 16 of whom, or 10.4 per cent., were found to be conducting their business in a commendable manner. The product of those who, after due warning, failed to adopt the suggestions offered, was excluded from sale within the limits of Springfield, by order of the local board of health. As soon as practicable, it is intended to inquire into the conditions obtaining at the farms in other States from which the Massachusetts supply is in part derived. This is proper and necessary, not only from the point of view of protection of the public health, but in justice to our home producers, who otherwise might fairly complain that, whereas they are compelled by local regulations to practice cleanliness and maintain sanitary conditions, their competitors beyond the borders of the Commonwealth are under no restraint whatever, and hence have an undue advantage.

| City or Town. | Total Number of Dairies examined. | Number of Dairies where One or More Objectionable Features were observed. | Number of Dairies found to be without Objectionable Feature. | Per Cent. Clean Dairies. |
|---|---|---|---|---|
| Agawam, | 83 | 81 | 2 | 2.41 |
| Amesbury, | 27 | 10 | 17 | 62.96 |
| Amherst, | 122 | 98 | 24 | 19.67 |
| Andover, | 16 | 6 | 10 | 62.50 |
| Arlington, | 12 | 7 | 5 | 41.67 |
| Ashburnham, | 13 | 12 | 1 | 7.69 |
| Auburn, | 37 | 24 | 13 | 35.14 |
| Barre, | 87 | 54 | 33 | 37.93 |

| City or Town. | Total Number of Dairies examined. | Number of Dairies where One or More Objectionable Features were observed. | Number of Dairies found to be without Objectionable Feature. | Per Cent. Clean Dairies. |
|---|---|---|---|---|
| Belmont, | 9 | 3 | 6 | 66.67 |
| Beverly, | 36 | 20 | 16 | 44.44 |
| Boxford, | 16 | 13 | 3 | 18.75 |
| Burlington, | 26 | 20 | 6 | 23.08 |
| Chelsea, | 21 | 19 | 2 | 9.52 |
| Danvers, | 55 | 33 | 22 | 40.00 |
| Dracut, | 53 | 43 | 10 | 18.87 |
| East Longmeadow, | 20 | 15 | 5 | 25.00 |
| Enfield, | 12 | 11 | 1 | 8.33 |
| Essex, | 50 | 27 | 23 | 46.00 |
| Everett, | 15 | 7 | 8 | 53.33 |
| Fitchburg, | 63 | 46 | 17 | 26.98 |
| Gardner, | 32 | 22 | 10 | 31.25 |
| Georgetown, | 11 | 3 | 8 | 72.73 |
| Gloucester, | 60 | 39 | 21 | 35.00 |
| Grafton, | 39 | 28 | 11 | 28.21 |
| Groveland, | 16 | 7 | 9 | 56.25 |
| Hadley, | 26 | 23 | 3 | 11.54 |
| Hamilton, | 15 | 10 | 5 | 33.33 |
| Hampden, | 31 | 28 | 3 | 9.68 |
| Haverhill, | 159 | 57 | 102 | 64.15 |
| Holden, | 44 | 29 | 15 | 34.09 |
| Holyoke, | 28 | 20 | 8 | 28.57 |
| Ipswich, | 49 | 36 | 13 | 26.53 |
| Lanesborough, | 11 | 10 | 1 | 9.09 |
| Leicester, | 21 | 15 | 6 | 28.57 |
| Leominster, | 76 | 47 | 29 | 38.16 |
| Lowell, | 17 | 12 | 5 | 29.41 |
| Ludlow, | 19 | 19 | - | - |
| Lunenburg, | 55 | 45 | 10 | 18.18 |
| Lynn, | 22 | 11 | 11 | 50.00 |
| Lynnfield, | 37 | 17 | 20 | 54.05 |
| Malden, | 27 | 22 | 5 | 18.52 |
| Marblehead, | 27 | 18 | 9 | 33.33 |
| Medford, | 43 | 9 | 34 | 79.07 |
| Melrose, | 14 | 6 | 8 | 57.14 |
| Merrimac, | 25 | 14 | 11 | 44.00 |
| Methuen, | 130 | 69 | 61 | 46.92 |

| City or Town. | Total Number of Dairies examined. | Number of Dairies where One or More Objectionable Features were observed. | Number of Dairies found to be without Objectionable Feature. | Per Cent. Clean Dairies. |
|---|---|---|---|---|
| Middleton, | 17 | 8 | 9 | 52.94 |
| Millbury, | 51 | 29 | 22 | 43.14 |
| Natick, | 15 | 10 | 5 | 33.33 |
| Newbury, | 46 | 36 | 10 | 21.74 |
| Newburyport, | 30 | 23 | 7 | 23.33 |
| Newton, | 70 | 47 | 23 | 32.86 |
| Northampton, | 31 | 28 | 3 | 9.68 |
| North Andover, | 43 | 15 | 28 | 65.12 |
| North Reading, | 19 | 6 | 13 | 68.42 |
| Oxford, | 11 | 9 | 2 | 18.18 |
| Paxton, | 29 | 21 | 8 | 27.59 |
| Peabody, | 42 | 20 | 22 | 52.38 |
| Pittsfield, | 33 | 23 | 10 | 30.30 |
| Reading, | 21 | 6 | 15 | 71.43 |
| Revere, | 13 | 11 | 2 | 15.38 |
| Rockport, | 20 | 17 | 3 | 15.00 |
| Rowley, | 33 | 26 | 7 | 21.21 |
| Rutland, | 40 | 26 | 14 | 35.00 |
| Salem, | 10 | 6 | 4 | 40.00 |
| Salisbury, | 37 | 29 | 8 | 21.62 |
| Saugus, | 37 | 33 | 4 | 10.81 |
| South Hadley, | 60 | 50 | 10 | 16.67 |
| Southwick, | 18 | 18 | - | - |
| Springfield, | 17 | 16 | 1 | 5.88 |
| Stoneham, | 22 | 17 | 5 | 22.73 |
| Sutton, | 47 | 39 | 8 | 17.02 |
| Swampscott, | 12 | 9 | 3 | 25.00 |
| Templeton, | 18 | 13 | 5 | 27.78 |
| Tewksbury, | 40 | 25 | 15 | 37.50 |
| Topsfield, | 40 | 28 | 12 | 30.00 |
| Tyngsborough, | 17 | 9 | 8 | 47.06 |
| Wakefield, | 23 | 13 | 10 | 43.48 |
| Waltham, | 35 | 20 | 15 | 42.86 |
| Watertown, | 16 | 9 | 7 | 43.75 |
| Wenham, | 29 | 18 | 11 | 37.93 |
| Westfield, | 33 | 31 | 2 | 6.06 |
| Westminster, | 23 | 18 | 5 | 21.74 |
| West Newbury, | 60 | 53 | 7 | 11.67 |

| City or Town. | Total Number of Dairies examined. | Number of Dairies where One or More Objectionable Features were observed. | Number of Dairies found to be without Objectionable Feature. | Per Cent. Clean Dairies. |
|---|---|---|---|---|
| West Springfield, | 16 | 13 | 3 | 18.75 |
| Whately, | 24 | 18 | 6 | 25.00 |
| Wilbraham, | 36 | 32 | 4 | 11.11 |
| Wilmington, | 21 | 9 | 12 | 57.14 |
| Winchendon, | 13 | 9 | 4 | 30.77 |
| Winchester, | 14 | 13 | 1 | 7.14 |
| Woburn, | 14 | 12 | 2 | 14.29 |
| Worcester, | 108 | 89 | 19 | 17.59 |
| Miscellaneous, | 56 | 44 | 12 | 21.42 |
| East Granby, Conn., | 4 | 4 | - | - |
| Enfield, Conn., | 17 | 15 | 2 | 11.76 |
| Somers, Conn., | 47 | 36 | 11 | 23.40 |
| Somersville, Conn., | 3 | 2 | 1 | 33.33 |
| Suffield, Conn., | 81 | 79 | 2 | 2.47 |
| West Stafford, Conn., | 2 | 2 | - | - |
| | 3,421 | 2,357 | 1,064 | 31.10 |

Under Miscellaneous are included dairies situated in the following towns, in no one of which were more than 8 inspected, the examinations having been made for some special reason and not as a part of a general investigation: —

Belchertown.
Canton.
Charlton.
Dalton.
Dedham.
Dunstable.
Easthampton.
Granville.
Hatfield.
Lenox.
Longmeadow.
Manchester.
Nahant.
Petersham.
Scituate.
Washington.
Westwood.

As is shown by the above table, the percentage of dairies found to be without objectionable conditions was 31.10. While this is very far from satisfactory, it is at least a considerable and gratifying improvement on the results presented in the annual report for 1905, in which year the work of inspection was begun. During the period covered by that report, only 20 per cent. of the dairies inspected were found to be in satisfactory condition. The improvement is doubtless due in part to a growing demand on the part of the public for a more wholesome supply and in part to a better understanding by the producers of the commercial advantage of more cleanly methods of production and of proper cooling and

handling. It has repeatedly been stated by a number of the leading contractors that during the past unusually hot summer the amount of milk received in sour condition and returned in consequence to the producer was never so small.

### Nature of the defects to which Attention was called.

The letters sent to 2,357 producers called attention to a total of 8,822 objectionable conditions. These were as follows: —

### Condition of Cows.

As stated above, in a very large number of instances the cows, being at pasture during the visit of the inspector, could not be examined. Of those that were seen and examined, a far smaller number were found to be diseased than during the seven months covered by the previous report. The period covered by the present report is, moreover, just twice as long.

A marked improvement was observed also in the matter of cleanliness, for whereas in the year 1905 a majority of the herds were reported as dirty to filthy, during the period covered by this report far less than half were so returned (955).

One of the contributing causes of uncleanliness of cows is the use of horse manure as bedding. During seven months of 1905 this practice was reported 182 times; during the fourteen months ended November, 1906, it was reported but 87 times.

### *Condition of Barns.*

*Light.* — In 1905 more than one-fourth of the cow barns were reported as badly lighted or not lighted at all. Of the 3,421 barns included in this report, less than one-fifth (638) were deficient in this respect.

*Ventilation.* — In 137 cases increased provision for entrance of fresh air was recommended. In 1905 the proportion of cases of inadequate ventilation was practically the same.

*General Cleanliness.* — More than one-sixth of the barns (590) were found to need cleaning in every part, and more than one-half of the tie-ups (1,881) were filthy and needed to be whitewashed. In 10 instances deposits of human excrement were observed on the barn floor, and in 69 the privy was situated near the tie-up. Accumulations of cow manure, in some instances immediately behind the cows, were noted on more than one-eighth (441) of the barn floors; and in a fairly large number of instances pools of liquid manure filled large depressions.

Other objectionable conditions reported included 80 cases of lack of proper drainage, 33 of foul condition of the cellar, 17 of old accumulations of manure in the cellar, 17 of broken floors, 14 of stabling cows

in foul cellars, 7 of the use of the barn floor for slaughtering purposes, 52 of storage of city swill, 44 of storage of sour brewers' grains, 9 of storage of rotting vegetables, and 3 of presence of decomposing dead fowls.

The keeping of swine in pens near the tie-up, the stabling of horses in the cow barn without separation by suitable partitions, and permitting poultry, sheep and goats to wander freely in the tie-up, are practices not compatible with the production of clean, wholesome milk. The separation of horses was recommended in 291 instances, the removal of swine in 318, and the restraint of poultry, sheep or goats in 11.

*Condition of Cow Yards.* — In nearly 700 instances the cow yard was found to be in a most objectionable state, principally on account of the presence of large pools of liquid manure, or of accumulated filth of various kinds. In 1 instance a putrefying carcass of a cow added its stench to that of the foul manure with which it was surrounded.

*Water Supplies.* — In 135 instances attention was called to the necessity of protecting the well from ordinary surface drainage, or from the overflow of cesspools.

*Milk Rooms.* — The place where milk is handled and stored should be kept in a scrupulously clean condition and free from all influences of an objectionable nature. In 126 cases the milk room was found to be very dirty; in 7, it was dark or unventilated; in 1, it was used also as a kennel, and in 2, dead animals were lying near by. The construction of a proper milk house or milk room was recommended in 182 cases.

*Care of Milk and Milk Utensils.* — The wholesomeness of milk and its commercial life period are greatly influenced by all the conditions under which it is drawn, handled and stored. It is not sufficient that the cows and the milkers and their clothing are clean. The condition of the milking pails and other utensils; the absence of dust and dirt where the processes of straining, cooling and handling are carried out; immediate cooling and proper storage, are alike important. In 32 instances the pails and mixing vessels ready for use were obviously unclean; in 696, the pails and cans were kept exposed to the dust of the barn; in 13, they were stored near swill, the privy, foul hen houses, or in the cow yard; in 2, they were washed close by overflowing privies, and in 1, in the tub used for the family washing. In 1,115 cases the milk was handled wholly in the more or less dusty barn, chiefly directly behind the cows; in 65, it was cooled under various other objectionable conditions, as near the privy, in the manure cellar and in foul tubs of dirty water; and in a considerable number of instances the place of final storage was used as well for storage of swill, fish, kerosene, rotting vegetables and other malodorous materials.

### Illustrations of Good and Bad Conditions.

The criticism is not infrequently heard that under present conditions the profitable production of clean, wholesome milk is practically impossible; that the cost of feed and of labor and the unwillingness of the consumers and contractors to pay a reasonable price per quart or can, together with the requirement of cleanly kept premises and animals, will drive the producer out of business. While it may be conceded that the profits of the producers are small, it can hardly be admitted that this may properly be advanced as an excuse for the grossly filthy conditions that are so often found to obtain. The assertion that reasonable cleanliness is incompatible with reasonable profit may be answered by the fact that during the period covered by this report nearly one-third of the 3,421 dairies examined were found to be conducted in a commendable manner, and that a very large proportion of those where objectionable conditions of one sort and another were noted have been put in proper order and have continued to supply the market. Indeed, in a number of instances where the cow barns were absolutely unfit for the proper housing of cattle and the production of wholesome milk, and could not be made so, the owners have built new ones, and have demolished the old, and with great satisfaction to themselves.

It is proper to remark that in the business of milk production are many whose fixed habits of general and personal uncleanliness are such that they are a menace to the public health and should not be allowed to market their unwholesome product, which should be placed in the same class with tainted meats and fish and dangerously adulterated foods of all kinds. Indeed, the public health suffers vastly more from dirty milk than from all the adulterated foods concerning which so many national and State laws have been enacted.

Illustrative of some of the objectionable conditions observed, and of the fact that clean barns need not be expensively constructed model dairies, the following reproductions of photographs taken during the progress of this investigation are presented: —

*Figure 1.* — It is sometimes said by captious critics of the milk law and its enforcement that the whole profit of the milk producer is the manure which his cattle yield. If this be true, there are many who appear to be disinclined to utilize this valuable product to best advantage. Instances have been reported in which the accumulation of years has been left untouched in the cellar. In Figure 1 is shown an example of lack of thrift and of general shiftlessness. The pool in the foreground represents the rich, watery extract of many tons of manure that might have been spread to great advantage over acres of land. It will be noted that

the barn is practically unprovided with windows. The condition of the interior may be judged by that of the surroundings.

*Figure 2.* — Figure 2 is another example of generally filthy conditions and lack of thrift. The black areas in the foreground represent the valuable extractive matters which have accumulated in liquid form in depressions. The markings on the side of the barn indicate the height of some preceding accumulations, showing that the present condition is not an exceptional one. The character of the surface of the ground in the immediate vicinity of this barn is easily surmised, and, as is the case with Figure 1, the conditions obtaining inside the barn may be judged by those of the exterior.

*Figure 3.* — The general character of the entire structure is evident from the defects shown in the part included in the figure. The cows occupy the shed on the right, which is ventilated through cracks and holes in the sides and roof. No light, other than that which penetrates these cracks and holes, reaches the interior, excepting when the door is open. The bin on the left is a wagon body containing sour, fermenting brewers' grains, which are given to the cows in lieu of proper food in the dirty tubs standing near by. On the day when the photograph was taken the foul odor from this material was perceptible at a distance of several hundred feet.

*Figure 4.* The enclosure shown in this figure receives its light and fresh air only through the cracks in the walls and roof. It shelters four cows and a considerable number of hens, which are not confined. The condition of the floor, only part of which is boarded, and the cobwebs on the roof indicate the degree of attention paid to cleanliness of the cows themselves and of the milk utensils.

*Figure 5.* — Figure 5 illustrates a not uncommon condition. The tie-up has a very defective floor, and overhead are seen overhanging hay, cobwebs and accumulated dirt. The wall is encrusted with manure, and the window is seen to be a wooden slide which, when closed, excludes the light as well as the air.

*Figure 6.* — In Figure 6 is illustrated the common practice above referred to of housing horses, cows and pigs in the same part of a barn. The position of the horse collar on the left marks the division line between the horses and the cows. The cows are lying in filth, which has not been removed for many weeks. Beyond them is a pig sty containing a sow and five young. On the right are swill tubs for the use of pigs and cows, as well as the house slop pail and other utensils. Before the photographs were taken the milk cans were standing next to the swill tubs, but they were removed by a member of the household. Overhead one sees hay and corn fodder, overhanging the entire tie-up.

*Figure 7.* — Figure 7 is presented to illustrate the statement that clean barns are not necessarily expensive in construction or management. The interior here shown is that of an old barn which has been put in proper repair, and which is kept clean and frequently whitewashed. On the extreme right is seen a bale of shavings, which material is excellent bedding for the cows. Each cow has access to a trough of running water, and in front of each is deposited daily a fresh portion of rock salt. The proprietor of this place has no difficulty in disposing of every quart of milk that he can raise, at a price which yields him a very good and well-deserved profit.

*Figure 8.* — Generally speaking, a basement tie-up is somewhat objectionable, but in the instance shown in this figure the conditions are not only unobjectionable, but are far superior to those which obtain in most barns on the floor above. The walls and timbers are frequently whitewashed. The light and ventilation are excellent, and the atmosphere is as free from disagreeable odors as could be wished.

*Figure 9.* — Herewith is presented the interior of a model dairy of inexpensive but first-class construction. It is well lighted, adequately ventilated and kept scrupulously clean. The manure is removed at frequent intervals during the day, and the cemented floor is frequently washed down with clean water.

*Figure 10.* — As stated above, the conditions under which milk is handled and stored are of quite as much importance as those under which it is produced. In Figures 10 to 14, inclusive, are shown good examples of most objectionable milk rooms. In the corner of Figure 10 is seen a primitive sink in which bottles and cans are given what cleaning they receive, and which is also used as a washing place for the proprietor himself. The floor and walls are thoroughly dirty, as is also everything else in the room.

*Figure 11.* — In Figure 11 is shown a combination milk room, harness room and storage place for feed of various kinds. While the interior is not as filthy as many others observed, its use as a place for handling and storing milk is not commendable.

*Figure 12.* — The white areas on the floor to the right of the centre, and the white drops on the lower edge of the shelf under the window, indicate recent use in the handling of milk, and from their presence and the cluttered condition of the room may be inferred the degree of care which is bestowed upon the premises, the cows, the milk utensils and the milk itself.

*Figure 13.* — Figure 13 shows a milk room, situated in the basement of a tenement house in a crowded quarter. On the right is a large tub of dirty water in which are immersed cans of milk, over which is

a piece of very dirty carpet. The sink and the tub, to the left of the centre, are used for the washing of cans and bottles. The tub is filled with dirty water, and its sides are covered to a depth of from one-fourth of an inch to a half inch with grease. The proprietor of this place raises part of his supply and buys the rest. He dispenses it in quart bottles.

*Figure 14.* — Figure 14 shows the milk-room end of a place which is part milk room and part wagon shed. On the left is a boiler in which the wooden stoppers of the cans are heated. On the right are two tubs in which the bottles and cans are washed. The sides of both of these tubs are covered thickly with grease, and the water which they contain is very foul in all respects. In the left upper portion of the figure are seen a number of cans over which is hanging a very dirty cloth which, on inquiry, was found to be the recently washed cloth which is used as a strainer for the milk. Its condition when washed indicates that which obtains while it is in use.

FIGURE 1.—COW BARN, WITH LITTLE PROVISION FOR LIGHT. TONS OF VALUABLE MANURE ALLOWED TO ACCUMULATE AND TO LOSE MUCH OF ITS VALUE THROUGH EXTRACTION OF ITS SOLUBLE CONSTITUENTS BY RAIN.

FIGURE 2.—AN EXAMPLE OF FILTHY CONDITIONS AND LACK OF THRIFT.

FIGURE 3.—Dilapidated, Unlighted Cow Barn. Bin containing Sour, Fermenting, Foul-smelling Brewers' Grains, fed to the Cows from Dirty Tubs.

FIGURE 4. — An Unlighted, Naturally Ventilated Pen for Four Cows and Numbers of Hens.

FIGURE 5. — TIE-UP WITH DIRTY, DEFECTIVE FLOOR, CEILING AND BACK.

FIGURE 6.—HORSES, COWS AND SWINE HOUSED SIDE BY SIDE. SWILL TUBS AND SLOP PAIL NEAR BY.

FIGURE 7.—AN OLD BARN, WITH CLEAN INTERIOR, PROPERLY KEPT.

FIGURE 8.— A Clean, Well-lighted and Well-ventilated Basement Tie-up.

FIGURE 9.—A MODEL, INEXPENSIVE TIE-UP

FIGURE 10. — OBJECTIONABLE CONDITIONS, COMMONLY OBSERVED.

FIGURE 11.—COMBINATION MILK ROOM, HARNESS ROOM AND STOREROOM FOR FEED.

FIGURE 12.—A FOUL MILK ROOM AND GENERAL STORAGE PLACE.

FIGURE 13. — A MILK ROOM IN THE BASEMENT OF A TENEMENT HOUSE.

FIGURE 14.—A FOUL MILK ROOM, WITH FOUL UTENSILS.

# REPORT

UPON THE

## PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN AND VACCINE,

## AND UPON BACTERIOLOGICAL DIAGNOSIS,

FOR THE

FOURTEEN MONTHS ENDED NOV. 30, 1906.

# REPORT

UPON THE

# PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN

FOR THE

## FOURTEEN MONTHS ENDED NOV. 30, 1906.

The production of diphtheria antitoxin has continued under the direction of Dr. Theobald Smith, at the Bussey Institute. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the eleven years and eight months ended Nov. 30, 1906, was as follows: —

| | |
|---|---|
| In 1895–1896 (year ended March 31), . . . . . | 1,724 bottles. |
| In 1896–1897 (year ended March 31), . . . . . | 3,219 bottles. |
| In 1897–1898 (year ended March 31), . . . . . | 4,668 bottles. |
| In 1898–1899 (year ended March 31), . . . . . | 12,491 bottles. |
| In 1899–1900 (year ended March 31), . . . . . | 31,997 bottles.[1] |
| In 1900–1901 (year ended March 31), . . . . . | 53,389 bottles.[1] |
| In 1901–1902 (year ended March 31), . . . . . | 40,211 bottles.[1] |
| In 1902–1903 (year ended March 31), . . . . . | 33,475 bottles.[1] |
| In 1903–1904 (year ended March 31), . . . . . | 41,133 bottles.[1] |
| During 6 months ended Sept. 30, 1904, . . . . . | 22,255 bottles.[1] |
| During 12 months ended Sept. 30, 1905, . . . . . | 47,387 bottles.[1] |
| During 14 months ended Nov. 30, 1906, . . . . . | 70,424 bottles.[1] |
| | 362,373 bottles. |

The serum was distributed to local boards of health, to hospitals, and to practitioners in 194 cities and towns, 61 of which used more than 100 bottles each. The following table shows the distribution: —

[1] These numbers have reference to the actual number of bottles issued in packages of about 1,500 units each. In order to make this comparable with the figures of the first three years (1895–98), a package of 1,000 units should be employed as a standard, so that the 269,847 bottles distributed since that time would be equivalent to about 405,000 of the strength at first employed.

*Number of Bottles of Diphtheria Antitoxin distributed from Oct. 1, 1905, to Nov. 30, 1906.*

| City or Town. | Number of Bottles. | City or Town. | Number of Bottles. |
|---|---|---|---|
| Abington, | 42 | Bridgewater, | 12 |
| Acton, | 12 | Brockton, | 875 |
| Adams, | 120 | Brookfield, | 8 |
| Agawam, | 27 | Brookline, | 470 |
| Amesbury, | 85 | Cambridge, | 3,224 |
| Andover, | 60 | Hospital, | 425 |
| Arlington, | 197 | Stillman Infirmary, | 65 |
| Ashby, | 6 | Canton, | 78 |
| Athol, | 18 | Chelsea, | 262 |
| Attleborough, | 60 | Cheshire, | 54 |
| Avon, | 6 | Chesterfield, | 4 |
| Ayer, | 46 | Chicopee, | 48 |
| Barnstable, | 6 | Clinton, | 111 |
| Barre, | 42 | Cohasset, | 12 |
| Bedford, | 7 | Colrain, | 6 |
| Belchertown, | 6 | Concord, | 100 |
| Bellingham, | 12 | Cottage City, | 18 |
| Belmont, | 48 | Dalton, | 74 |
| Beverly, | 192 | Danvers, | 211 |
| Blackstone, | 36 | Dedham, | 138 |
| Boston: — | | Dighton, | 36 |
| Children's Hospital, | 2,138 | Douglas, | 9 |
| City Hospital, | 16,376 | Duxbury, | 14 |
| Deer Island Hospital, | 18 | East Bridgewater, | 6 |
| General supply, | 8,479 | East Longmeadow, | 12 |
| Infants' Hospital, | 84 | Easthampton, | 12 |
| Long Island Hospital, | 84 | Easton, | 12 |
| Massachusetts Charitable Eye and Ear Infirmary. | 28 | Erving, | 25 |
| Massachusetts General Hospital, | 175 | Essex, | 12 |
| Massachusetts Homœopathic Hospital. | 75 | Everett, | 261 |
| Massachusetts Infant Asylum, | 26 | Fall River, | 917 |
| Saint Mary's Hospital, | 150 | Falmouth, | 48 |
| Training ship "Enterprise," | 12 | Fitchburg, | 300 |
| Bourne, | 12 | Foxborough, | 18 |
| Boylston, | 6 | Framingham, | 60 |
| Braintree, | 24 | Gardner, | 42 |

*Number of Bottles of Diphtheria Antitoxin distributed from Oct. 1, 1905, to Nov. 30, 1906* — Continued.

| City or Town. | Number of Bottles. | City or Town. | Number of Bottles. |
|---|---|---|---|
| Georgetown, | 24 | Marlborough, | 62 |
| Gloucester, | 1,667 | Marshfield, | 30 |
| Great Barrington, | 42 | Maynard, | 126 |
| Greenfield, | 42 | Medfield, | 60 |
| Groton, | 8 | Medford, | 204 |
| Hadley, | 14 | Medway, | 18 |
| Hanover, | 10 | Melrose, | 156 |
| Hanson, | 8 | Merrimac, | 51 |
| Hardwick, | 185 | Methuen, | 120 |
| Haverhill, | 1,058 | Middleborough, | 6 |
| Hingham, | 24 | Milford, | 319 |
| Hinsdale, | 12 | Millbury, | 24 |
| Holbrook, | 78 | Millis, | 12 |
| Holden, | 12 | Milton, | 70 |
| Holliston, | 30 | Monson, | 54 |
| Holyoke, | 536 | Nantucket, | 24 |
| Hopedale, | 61 | Natick, | 124 |
| Hopkinton, | 30 | Needham, | 113 |
| Hudson, | 71 | New Bedford, | 2,142 |
| Hull, | 61 | Newbury, | 18 |
| Hyde Park, | 302 | Newburyport, | 145 |
| Lanesborough, | 12 | Newton, | 883 |
| Lawrence, | 1,308 | North Adams, | 434 |
| Lee, | 12 | North Andover, | 54 |
| Leicester, | 72 | North Attleborough, | 103 |
| Lenox, | 6 | North Brookfield, | 14 |
| Leominster, | 437 | North Reading, | 12 |
| Lexington, | 12 | Northampton, | 66 |
| Littleton, | 4 | Northbridge, | 30 |
| Lowell, | 1,967 | Northfield, | 18 |
| Ludlow, | 12 | Norton, | 3 |
| Lynn, | 1,627 | Norwell, | 30 |
| Malden, | 375 | Norwood, | 66 |
| Manchester, | 83 | Orange, | 18 |
| Mansfield, | 109 | Oxford, | 6 |
| Marblehead, | 134 | Palmer, | 12 |

*Number of Bottles of Diphtheria Antitoxin distributed from Oct. 1, 1905, to Nov. 30, 1906* — Concluded.

| City or Town. | Number of Bottles. |
|---|---|
| Palmer — *Con.* | |
| State Hospital, | 6 |
| Peabody, | 235 |
| Pembroke, | 22 |
| Pittsfield, | 542 |
| Plymouth, | 30 |
| Princeton, | 18 |
| Provincetown, | 61 |
| Quincy, | 1,001 |
| Randolph, | 18 |
| Reading, | 229 |
| Revere, | 206 |
| Rockland, | 18 |
| Rockport, | 12 |
| Rowley, | 14 |
| Salem, | 1,949 |
| Saugus, | 232 |
| Scituate, | 42 |
| Shelburne, | 6 |
| Shirley, | 48 |
| Somerville, | 2,250 |
| Hospital, | 450 |
| Southbridge, | 287 |
| Spencer, | 36 |
| Springfield, | 925 |
| Stockbridge, | 25 |
| Stoneham, | 36 |
| Stoughton, | 30 |
| Stow, | 6 |
| Sturbridge, | 15 |
| Sutton, | 54 |
| Swampscott, | 42 |
| Swansea, | 4 |
| Taunton, | 344 |
| Tewksbury, State Hospital, | 52 |
| Tisbury, | 12 |
| Topsfield, | 25 |
| Townsend, | 6 |
| Uxbridge, | 12 |
| Wakefield, | 217 |
| Walpole, | 48 |
| Waltham, | 385 |
| Hospital, | 1,488 |
| Ware, | 378 |
| Wareham, | 6 |
| Warren, | 12 |
| Warwick, | 36 |
| Watertown, | 106 |
| Wayland, | 18 |
| Webster, | 68 |
| Wellesley, | 60 |
| West Bridgewater, | 24 |
| West Brookfield, | 4 |
| West Springfield, | 75 |
| Westfield, | 90 |
| Westford, | 4 |
| Westport, | 28 |
| Weymouth, | 217 |
| Whitman, | 60 |
| Wilbraham, | 12 |
| Williamstown, | 72 |
| Wilmington, | 36 |
| Winchendon, | 24 |
| Winchester, | 188 |
| Winthrop, | 190 |
| Woburn, | 117 |
| Worcester, | 4,642 |
| Worthington, | 6 |
| Total, | 70,424 |

The vaccine virus was distributed as shown in the following table: —

*Number of Tubes of Vaccine distributed from Oct. 1, 1905, to Nov. 30, 1906.*

| City or Town. | Number of Tubes. | City or Town. | Number of Tubes. |
|---|---|---|---|
| Abington, | 49 | Georgetown, | 65 |
| Acton, | 3 | Groton, | 10 |
| Amesbury, | 60 | Hingham, | 174 |
| Arlington, | 270 | Holbrook, | 98 |
| Attleborough, | 182 | Holden, | 21 |
| Ayer, | 8 | Hull, | 20 |
| Bedford, | 12 | Hyde Park, | 29 |
| Boston: — | | Lawrence, | 1,825 |
| Children's Hospital, | 15 | Lee, | 25 |
| City Hospital, | 710 | Lexington, | 78 |
| General supply, | 8,812 | Lincoln, | 9 |
| Infants' Hospital, | 202 | Lowell, | 25 |
| Long Island Hospital, | 6 | Mansfield, | 35 |
| Massachusetts General Hospital, | 155 | Marshfield, | 15 |
| Penal institutions, | 4,075 | Medfield, | 96 |
| St. Elizabeth's Hospital, | 90 | Medford, | 9 |
| Braintree, | 101 | Medway, | 12 |
| Bridgewater, | 51 | Melrose, | 181 |
| Brockton, | 100 | Methuen, | 156 |
| Brookfield, | 10 | Milford, | 600 |
| Brookline, | 648 | Millbury, | 86 |
| Cambridge, | 723 | Milton, | 96 |
| Chelsea, | 100 | Needham, | 30 |
| Clinton, | 369 | Newton, | 525 |
| Cohasset, | 95 | North Adams, | 25 |
| Colrain, | 6 | North Attleborough, | 252 |
| Concord, | 50 | Norwood, | 140 |
| State Reformatory, | 300 | Orange, | 6 |
| Dedham, | 625 | Oxford, | 5 |
| Duxbury, | 39 | Palmer, | 90 |
| East Bridgewater, | 30 | State Hospital, | 139 |
| Everett, | 181 | Pembroke, | 5 |
| Fall River, | 2,855 | Plymouth, | 65 |
| Fitchburg, | 752 | Provincetown, | 25 |
| Foxborough, | 20 | Quincy, | 771 |
| State Hospital, | 125 | Randolph, | 15 |
| Gardner, | 30 | Rockland, | 215 |

*Number of Tubes of Vaccine distributed from Oct. 1, 1905, to Nov. 30, 1906* — Concluded.

| City or Town. | Number of Tubes. | City or Town. | Number of Tubes. |
|---|---|---|---|
| Salem, | 10 | Waverley: — | |
| Sharon, | 11 | McLean Hospital, | 90 |
| Sherborn, | 70 | Wayland, | 20 |
| Somerville, | 739 | Wellesley, | 116 |
| Springfield, | 960 | West Springfield, | 34 |
| Stoughton, | 30 | Westfield, | 136 |
| Taunton, | 646 | Westford, | 18 |
| Tisbury, | 6 | Westport, | 52 |
| Townsend, | 26 | Weymouth, | 252 |
| Wakefield, | 171 | Whitman, | 46 |
| Walpole, | 68 | Wilmington, | 5 |
| Waltham, | 365 | Woburn, | 24 |
| Ware, | 50 | Worcester, | 500 |
| Warren, | 80 | Total, | 31,805 |
| Watertown, | 6 | | |

# Report upon Diphtheria Cultures examined during the Fourteen Months ended Nov. 30, 1906.

From Oct. 1, 1905, to Nov. 30, 1906, 4,133 cultures were received from 145 cities and towns in the State. Of these cultures, 1,919 were for the purpose of diagnosis, 2,209 were for release from quarantine and 5 were unclassified. The following table gives the number of cultures received from the different towns and cities and the results of the examinations: —

| City or Town. | Whole Number of Cultures examined. | Cultures examined for Diagnosis. | | | Cultures examined for Release from Quarantine. |
|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | |
| Abington, | 1 | 1 | - | - | - |
| Acton, | 2 | 1 | 1 | - | - |
| Adams, | 4 | 1 | 2 | - | 1 |
| Amesbury, | 2 | - | 2 | - | - |
| Andover, | 10 | 2 | 8 | - | - |
| Arlington, | 90 | 20 | 15 | - | 55 |
| Ashby, | 1 | - | - | - | 1 |
| Athol, | 13 | 1 | 9 | - | 3 |
| Attleborough, | 26 | 13 | 11 | - | 2 |
| Avon, | 4 | 1 | 2 | - | 1 |
| Ayer, | 4 | - | 4 | - | - |
| Barnstable, | 4 | 1 | 2 | - | 1 |
| Belmont, | 5 | - | 1 | - | 4 |
| Beverly, | 131 | 32 | 30 | 1 | 68 |
| Bolton, | 1 | - | 1 | - | - |
| Boston, | 3 | - | 2 | - | 1 |
| Bourne, | 7 | 1 | 3 | - | 3 |
| Boxford, | 2 | - | - | - | 2 |
| Braintree, | 10 | 2 | 5 | - | 3 |
| Bridgewater, | 10 | 5 | - | - | 5 |
| Brookline, | 2 | - | 2 | - | - |
| Cambridge, | 7 | - | 2 | - | 5 |

| City or Town. | Whole Number of Cultures examined. | Cultures examined for Diagnosis. | | | Cultures examined for Release from Quarantine. |
|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | |
| Canton, | 23 | 5 | 3 | - | 15 |
| Carlisle, | 3 | - | 2 | - | 1 |
| Chelsea, | 80 | 8 | 24 | 1 | 47 |
| Cheshire, | 23 | 4 | 1 | - | 18 |
| Clinton, | 2 | - | 1 | - | 1 |
| Concord, | 20 | 3 | 10 | - | 7 |
| Danvers, | 88 | 14 | 31 | - | 43 |
| Dartmouth, | 2 | 2 | - | - | - |
| Dedham, | 32 | 5 | 22 | - | 5 |
| Dennis, | 2 | - | - | - | 2 |
| Dover, | 2 | - | 2 | - | - |
| Duxbury, | 43 | 3 | 9 | - | 31 |
| East Bridgewater, | 2 | - | 2 | - | - |
| Easton, | 2 | - | 2 | - | - |
| Edgartown, | 5 | 1 | 1 | - | 3 |
| Everett, | 218 | 41 | 41 | 1 | 135 |
| Falmouth, | 64 | 8 | 7 | 1 | 48 |
| Florida, | 1 | - | - | - | 1 |
| Foxborough, | 23 | 3 | 13 | - | 7 |
| Framingham, | 3 | 2 | 1 | - | - |
| Gardner, | 2 | 1 | - | - | 1 |
| Gloucester, | 3 | - | 2 | - | 1 |
| Great Barrington, | 14 | 4 | 4 | - | 6 |
| Groton, | 14 | 2 | 6 | - | 6 |
| Hamilton, | 4 | 1 | - | - | 3 |
| Hanover, | 1 | - | 1 | - | - |
| Hanson, | 2 | - | 1 | - | 1 |
| Hardwick, | 61 | 10 | 11 | 1 | 39 |
| Haverhill, | 4 | 4 | - | - | - |
| Hingham, | 26 | 3 | 21 | - | 2 |
| Holbrook, | 14 | 3 | 8 | 1 | 2 |
| Holliston, | 4 | 1 | 2 | - | 1 |
| Hopedale, | 1 | 1 | - | - | - |
| Hopkinton, | 5 | 2 | 3 | - | - |
| Hubbardston, | 1 | - | 1 | - | - |
| Hudson, | 1 | - | 1 | - | - |
| Hull, | 29 | 3 | 15 | - | 11 |
| Hyde Park, | 80 | 12 | 22 | 1 | 45 |

| City or Town. | Whole Number of Cultures examined. | Cultures examined for Diagnosis. | | | Cultures examined for Release from Quarantine. |
|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | |
| Ipswich, . . . . . . . . | 3 | - | 2 | - | 1 |
| Lancaster, . . . . . . . | 9 | 2 | 1 | - | 6 |
| Lawrence, . . . . . . . . | 18 | 7 | 10 | - | 1 |
| Littleton, . . . . . . . . | 3 | 1 | 2 | - | - |
| Ludlow, . . . . . . . . | 2 | - | 1 | - | 1 |
| Lynnfield, . . . . . . . . | 2 | - | - | - | 2 |
| Malden, . . . . . . . . | 224 | 35 | 54 | 1 | 134 |
| Manchester, . . . . . . . | 17 | 8 | 4 | - | 5 |
| Mansfield, . . . . . . . . | 79 | 21 | 18 | - | 40 |
| Marblehead, . . . . . . . | 136 | 23 | 48 | - | 65 |
| Marlborough, . . . . . . . | 30 | 5 | 20 | - | 5 |
| Marshfield, . . . . . . . . | 18 | 1 | 7 | - | 10 |
| Medfield, . . . . . . . . | 11 | - | 5 | - | 6 |
| Medford, . . . . . . . . | 173 | 35 | 65 | 2 | 71 |
| Medway, . . . . . . . . | 1 | - | 1 | - | - |
| Melrose, . . . . . . . . | 93 | 16 | 33 | 2 | 42 |
| Mendon, . . . . . . . . | 2 | 1 | 1 | - | - |
| Methuen, . . . . . . . . | 1 | - | 1 | - | - |
| Millis, . . . . . . . . | 10 | 3 | 2 | - | 5 |
| Milton, . . . . . . . . | 56 | 4 | 24 | - | 28 |
| Natick, . . . . . . . . | 37 | 16 | 15 | - | 6 |
| Needham, . . . . . . . . | 23 | 11 | 4 | - | 8 |
| Newbury, . . . . . . . . | 4 | - | - | - | 4 |
| Newburyport, . . . . . . . | 15 | 4 | 9 | - | 2 |
| North Adams, . . . . . . . | 195 | 26 | 39 | - | 130 |
| North Andover, . . . . . . | 1 | - | 1 | - | - |
| North Attleborough, . . . . . | 10 | 5 | 5 | - | - |
| North Brookfield, . . . . . . | 1 | 1 | - | - | - |
| North Reading, . . . . . . . | 6 | 1 | 4 | - | 1 |
| Northfield, . . . . . . . . | 6 | - | 6 | - | - |
| Norwell, . . . . . . . . | 5 | 1 | 2 | - | 2 |
| Norwood, . . . . . . . . | 9 | 1 | 8 | - | - |
| Peabody, . . . . . . . . | 58 | 8 | 8 | - | 42 |
| Pembroke, . . . . . . . . | 5 | 1 | 2 | - | 2 |
| Pepperell, . . . . . . . . | 2 | 2 | - | - | - |
| Plymouth, . . . . . . . . | 7 | 1 | 1 | - | 5 |
| Princeton, . . . . . . . . | 1 | - | 1 | - | - |
| Provincetown, . . . . . . . | 14 | 2 | 5 | - | 7 |

| City or Town. | Whole Number of Cultures examined. | Cultures examined for Diagnosis. | | | Cultures examined for Release from Quarantine. |
|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | |
| Quincy, | 68 | 18 | 41 | 1 | 8 |
| Randolph, | 6 | 2 | 2 | - | 2 |
| Reading, | 69 | 18 | 13 | - | 38 |
| Revere, | 53 | 6 | 17 | - | 30 |
| Rockland, | 12 | 1 | 10 | - | 1 |
| Rockport, | 1 | 1 | - | - | - |
| Salem, | 414 | 48 | 40 | - | 326 |
| Sandwich, | 1 | - | 1 | - | - |
| Saugus, | 88 | 13 | 30 | - | 45 |
| Scituate, | 30 | 5 | 12 | - | 13 |
| Sheffield, | 6 | 1 | - | - | 5 |
| Shelburne, | 2 | - | 2 | - | - |
| Sherborn, | 1 | - | 1 | - | - |
| Shirley, | 33 | 8 | 9 | - | 16 |
| Southbridge, | 181 | 7 | 19 | - | 155 |
| Spencer, | 1 | - | - | - | 1 |
| Stockbridge, | 17 | - | - | - | 17 |
| Stoneham, | 7 | - | 5 | 2 | - |
| Stoughton, | 30 | 6 | 15 | - | 9 |
| Sturbridge, | 7 | 2 | 3 | - | 2 |
| Sutton, | 39 | 1 | 1 | - | 37 |
| Swampscott, | 23 | 3 | 13 | - | 7 |
| Taunton, | 37 | 12 | 20 | 1 | 4 |
| Tewksbury, | 1 | - | 1 | - | - |
| Tisbury, | 4 | 2 | - | - | 2 |
| Upton, | 1 | - | 1 | - | - |
| Wakefield, | 19 | 3 | 11 | - | 5 |
| Walpole, | 24 | 6 | 4 | 1 | 13 |
| Ware, | 2 | 1 | 1 | - | - |
| Warren, | 6 | 2 | 2 | - | 2 |
| Watertown, | 124 | 13 | 23 | - | 88 |
| Wayland, | 8 | 2 | 3 | - | 3 |
| Wellesley, | 17 | 2 | 13 | - | 2 |
| Wenham, | 1 | - | 1 | - | - |
| West Brookfield, | 1 | - | 1 | - | - |
| Westfield, | 37 | 11 | 9 | 1 | 16 |
| Westwood, | 1 | - | - | - | 1 |
| Weymouth, | 22 | 2 | 14 | - | 6 |
| Whitman, | 8 | 4 | 2 | - | 2 |

| City or Town. | Whole Number of Cultures examined. | Cultures examined for Diagnosis. | | | Cultures examined for Release from Quarantine. |
|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | |
| Williamstown, | 2 | - | 2 | - | - |
| Wilmington, | 13 | 3 | 5 | - | 5 |
| Winchendon, | 2 | - | 2 | - | - |
| Winchester, | 102 | 15 | 41 | - | 46 |
| Winthrop, | 60 | 12 | 18 | - | 30 |
| Woburn, | 14 | - | 10 | - | 4 |
| Wrentham, | 1 | - | 1 | - | - |
| Yarmouth, | 2 | - | 2 | - | - |
| Unclassified, | 5 | - | - | - | - |
| Total, | 4,133 | 699 | 1,202 | 18 | 2,209 |

## Summary.

The whole number of cultures examined since the bacteriological diagnosis of diphtheria was undertaken by the Board is as follows:

| | |
|---|---|
| In 1896–1897 (year ended March 31, 1897), | 1,469 |
| In 1897–1898 (year ended March 31, 1898), | 2,204 |
| In 1898–1899 (year ended March 31, 1899), | 1,591 |
| In 1899–1900 (year ended March 31, 1900), | 3,258 |
| In 1900–1901 (year ended March 31, 1901), | 5,173 |
| In 1901–1902 (year ended March 31, 1902), | 4,119 |
| In 1902–1903 (year ended March 31, 1903), | 2,904 |
| In 1903–1904 (year ended March 31, 1904), | 3,632 |
| In 1904 (from April 1 to Sept. 30, inclusive), | 1,014 |
| In 1904–1905 (year ended Sept. 30, 1905), | 3,382 |
| In 1905–1906 (fourteen months ended Nov. 30, 1906), | 4,133 |
| Total, | 32,879 |

# REPORT UPON THE EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From Oct. 1, 1905, to Nov. 30, 1906, microscopical examination has been made of 1,576 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 163 different cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examinations: —

| City or Town. | Whole Number of Examinations. | Primary Examination. | | | City or Town. | Whole Number of Examinations. | Primary Examination. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Positive. | Negative. | Doubtful. | | | Positive. | Negative. | Doubtful. |
| Abington, | 7 | 4 | 3 | - | Bourne, | 3 | 1 | 2 | - |
| Acton, | 1 | 1 | - | - | Boxford, | 1 | 1 | - | - |
| Adams, | 2 | 1 | 1 | - | Braintree, | 7 | 5 | 2 | - |
| Amesbury, | 3 | - | 3 | - | Bridgewater, | 4 | 1 | 3 | - |
| Andover, | 2 | 1 | 1 | - | Brockton, | 2 | - | 2 | - |
| Arlington, | 10 | 4 | 6 | - | Burlington, | 1 | - | 1 | - |
| Ashland, | 6 | - | 6 | - | Cambridge, | 4 | 1 | 3 | - |
| Athol, | 3 | 3 | - | - | Canton, | 1 | - | 1 | - |
| Attleborough, | 12 | 3 | 9 | - | Carver, | 1 | - | 1 | - |
| Avon, | 1 | - | 1 | - | Chelmsford, | 1 | - | 1 | - |
| Ayer, | 2 | 1 | 1 | - | Chelsea, | 21 | 4 | 17 | - |
| Barnstable, | 3 | 1 | 2 | - | Chesterfield, | 1 | - | 1 | - |
| Barre, | 1 | - | 1 | - | Clinton, | 1 | 1 | - | - |
| Bedford, | 3 | - | 3 | - | Concord, | 2 | - | 2 | - |
| Belmont, | 3 | - | 2 | 1 | Concord, Massachusetts Reformatory, | 15 | 6 | 9 | - |
| Beverly, | 16 | 5 | 11 | - | Danvers, | 25 | 10 | 15 | - |
| Billerica, | 1 | - | 1 | - | Dartmouth, | 2 | - | 2 | - |
| Blackstone, | 13 | 4 | 9 | - | Dedham, | 14 | 3 | 11 | - |
| Boston, | 12 | 4 | 8 | - | East Bridgewater, | 4 | - | 4 | - |

| City or Town. | Whole Number of Examinations. | Primary Examination. Positive. | Primary Examination. Negative. | Primary Examination. Doubtful. |
|---|---|---|---|---|
| Egremont, | 1 | - | 1 | - |
| Everett, | 52 | 16 | 35 | 1 |
| Fall River, | 218 | 83 | 134 | 1 |
| Foxborough, | 20 | 3 | 17 | - |
| Framingham, | 12 | 2 | 10 | - |
| Franklin, | 3 | 2 | 1 | - |
| Gardner, | 7 | 4 | 3 | - |
| Gill, | 1 | 1 | - | - |
| Gloucester, | 6 | 3 | 3 | - |
| Great Barrington, | 3 | - | 3 | - |
| Greenfield, | 12 | 4 | 8 | - |
| Groton, | 1 | 1 | - | - |
| Groveland, | 1 | - | 1 | - |
| Halifax, | 1 | 1 | - | - |
| Hamilton, | 2 | 1 | 1 | - |
| Hanover, | 4 | - | 4 | - |
| Hanson, | 2 | 2 | - | - |
| Harvard, | 1 | - | 1 | - |
| Haverhill, | 4 | 2 | 2 | - |
| Hingham, | 15 | 8 | 7 | - |
| Hinsdale, | 1 | - | 1 | - |
| Holbrook, | 1 | - | 1 | - |
| Holden, | 22 | 4 | 18 | - |
| Hopkinton, | 1 | 1 | - | - |
| Hudson, | 1 | - | 1 | - |
| Hull, | 3 | - | 3 | - |
| Hyde Park, | 36 | 11 | 25 | - |
| Ipswich, | 4 | 2 | 2 | - |
| Lakeville, | 1 | 1 | - | - |
| Lawrence, | 90 | 28 | 60 | 2 |
| Lee, | 1 | - | 1 | - |
| Lexington, | 15 | 4 | 11 | - |
| Littleton, | 3 | - | 3 | - |
| Lynn, | 11 | 5 | 6 | - |
| Lynnfield, | 2 | 1 | 1 | - |
| Malden, | 20 | 7 | 13 | - |
| Manchester, | 4 | 1 | 3 | - |
| Mansfield, | 24 | 6 | 18 | - |
| Marblehead, | 1 | - | 1 | - |
| Marlborough, | 21 | 8 | 13 | - |
| Marshfield, | 5 | 4 | 1 | - |
| Maynard, | 6 | 4 | 2 | - |
| Medfield, | 1 | 1 | - | - |
| Medford, | 25 | 9 | 16 | - |
| Medway, | 3 | 1 | 2 | - |
| Melrose, | 35 | 12 | 23 | - |
| Merrimac, | 3 | 1 | 2 | - |
| Methuen, | 2 | - | 2 | - |
| Middleborough, | 7 | 3 | 4 | - |
| Middleton, | 1 | 1 | - | - |
| Milford, | 5 | 1 | 4 | - |
| Millis, | 1 | - | 1 | - |
| Milton, | 2 | - | 2 | - |
| Natick, | 26 | 7 | 18 | 1 |
| Needham, | 12 | 3 | 9 | - |
| New Bedford, | 5 | 3 | 2 | - |
| Newburyport, | 2 | 2 | - | - |
| Newton, | 3 | 3 | - | - |
| Norfolk, | 2 | 2 | - | - |
| North Adams, | 70 | 27 | 42 | 1 |
| North Attleborough, | 33 | 8 | 25 | - |
| Northborough, | 1 | 1 | - | - |
| Northfield, | 2 | 1 | 1 | - |
| Norton, | 5 | 2 | 3 | - |
| Norwood, | 21 | 7 | 14 | - |
| Orange, | 1 | 1 | - | - |
| Oxford, | 3 | 3 | - | - |
| Palmer, | 1 | - | 1 | - |
| Peabody, | 30 | 9 | 21 | - |
| Pembroke, | 1 | 1 | - | - |
| Petersham, | 1 | - | 1 | - |
| Pittsfield, | 9 | 2 | 7 | - |
| Plainfield, | 3 | - | 3 | - |
| Plymouth, | 2 | - | 2 | - |

| City or Town. | Whole Number of Examinations. | Primary Examination. Positive. | Negative. | Doubtful. | City or Town. | Whole Number of Examinations. | Primary Examination. Positive. | Negative. | Doubtful. |
|---|---|---|---|---|---|---|---|---|---|
| Quincy, | 59 | 15 | 42 | 2 | Tyngsborough, | 3 | - | 3 | - |
| Randolph, | 14 | 5 | 9 | - | Wakefield, | 10 | 1 | 9 | - |
| Raynham, | 1 | - | 1 | - | Walpole, | 3 | - | 3 | - |
| Reading, | 11 | - | 11 | - | Waltham, | 2 | - | 2 | - |
| Revere, | 22 | 10 | 12 | - | Ware, | 5 | 1 | 4 | - |
| Rockland, | 11 | 3 | 8 | - | Watertown, | 3 | - | 3 | - |
| Rutland, | 1 | - | 1 | - | Wayland, | 2 | - | 2 | - |
| Salem, | 36 | 13 | 23 | - | Wellesley, | 15 | 3 | 11 | 1 |
| Salisbury, | 1 | 1 | - | - | Westborough, | 3 | 1 | 2 | - |
| Saugus, | 11 | 3 | 8 | - | West Brookfield, | 4 | 1 | 3 | - |
| Scituate, | 3 | 1 | 2 | - | West Bridgewater, | 1 | - | 1 | - |
| Sharon, | 1 | - | 1 | - | Westfield, | 27 | 7 | 20 | - |
| Sheffield, | 2 | - | 2 | - | Westford, | 5 | - | 5 | - |
| Shelburne, | 1 | - | 1 | - | Weston, | 1 | 1 | - | - |
| Sherborn, | 4 | 1 | 3 | - | Westport, | 1 | - | 1 | - |
| Shirley, | 2 | 1 | 1 | - | Weymouth, | 10 | 2 | 8 | - |
| Somerville, | 2 | 1 | 1 | - | Whitman, | 4 | 2 | 2 | - |
| Southampton, | 2 | 1 | 1 | - | Williamstown, | 7 | 2 | 5 | - |
| Spencer, | 3 | 2 | 1 | - | Wilmington, | 12 | 2 | 10 | - |
| Springfield, | 1 | - | 1 | - | Winchendon, | 4 | - | 4 | - |
| Stoneham, | 4 | 1 | 3 | - | Winchester, | 16 | 3 | 13 | - |
| Sturbridge, | 3 | - | 3 | - | Winthrop, | 12 | 3 | 9 | - |
| Sutton, | 1 | - | 1 | - | Woburn, | 5 | 3 | 2 | - |
| Swansea, | 1 | 1 | - | - | Wrentham, | 1 | 1 | - | - |
| Taunton, | 50 | 22 | 28 | - | Unclassified, | 1 | - | 1 | - |
| Topsfield, | 1 | - | 1 | - | Total, | 1,576 | 512 | 1,054 | 10 |
| Townsend, | 3 | 2 | 1 | - | | | | | |

## SUMMARY.

The number of samples of sputum and other material examined for the bacilli of tuberculosis since these examinations were undertaken by the Board is as follows: —

| | |
|---|---|
| In 1896-1897 (year ended March 31, 1897), | 124 |
| In 1897-1898 (year ended March 31, 1898), | 236 |
| In 1898-1899 (year ended March 31, 1899), | 414 |
| In 1899-1900 (year ended March 31, 1900), | 571 |
| In 1900-1901 (year ended March 31, 1901), | 746 |
| In 1901-1902 (year ended March 31, 1902), | 797 |
| In 1902-1903 (year ended March 31, 1903), | 928 |
| In 1903-1904 (year ended March 31, 1904), | 1,006 |
| In 1904 (from April 1 to Sept. 30, inclusive), | 494 |
| In 1904-1905 (year ended Sept. 30, 1905), | 1,090 |
| In 1905-1906 (fourteen months ended Nov. 30, 1906), | 1,576 |
| Total, | 7,982 |

# TYPHOID FEVER.

## WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the fourteen months ended Nov. 30, 1906, the Widal test was carried out with 820 specimens of blood. In 6 instances the result was not decisive. Of the 814 cases in which the result of test was definite, 296, or 36.3 per cent., gave a positive reaction. Specimens were sent in from 91 cities or towns. These facts are shown in detail in Table I. In a second table (Table II.) the specimens, positive and negative, are classified according to the day of the disease on which they were collected. The table shows that a fair percentage of positive results is obtained during the first week of the disease, but this is probably due to the uncertainty as to exact length of time the patients have been ill. A moderate number of second and third specimens from the same case were examined so that the total number of tests made is somewhat over the number of cases of disease concerned. The methods used during the year were the same as those previously in use in the laboratory, and they have been amply described in the reports of the year 1900 and the years following.

TABLE I — *Widal Test, Oct. 1, 1905, to Nov. 30, 1906, inclusive. Classified according to the City or Town from which the Specimen was sent.*

| CITY OR TOWN. | Number of Cases. | Positive. | Negative. |
|---|---|---|---|
| Arlington, | 20 | 10 | 10 |
| Attleborough, | 3 | – | 3 |
| Ayer, | 3 | 2 | 1 |
| Barnstable, | 3 | – | 3 |
| Belmont, | 1 | 1 | – |
| Beverly, | 6 | 2 | 4 |
| Boston, | 2 | 1 | 1 |
| Boxford, | 1 | – | 1 |
| Brewster, | 1 | – | 1 |
| Brimfield, | 1 | – | 1 |
| Brookline, | 1 | 1 | – |
| Cambridge, | 7 | 3 | 4 |
| Canton, | 2 | – | 2 |
| Chelsea, | 12 | 6 | 6 |
| Chilmark, | 2 | 2 | – |
| Concord, | 6 | – | 6 |
| Danvers, | 12 | 1 | 11 |
| Dedham, | 3 | 1 | 2 |
| Dighton, | 1 | – | 1 |
| Easton, | 1 | – | 1 |
| Everett, | 33 | 10 | 23 |
| Foxborough, | 1 | – | 1 |
| Framingham, | 3 | – | 3 |
| Gloucester, | 1 | – | 1 |
| Hanover, | 1 | – | 1 |
| Hanson, | 3 | 1 | 2 |
| Haverhill, | 4 | – | 4 |
| Hingham, | 5 | 2 | 3 |
| Holbrook, | 2 | 1 | 1 |
| Holden, | 6 | – | 6 |
| Hopedale, | 2 | – | 2 |
| Hull, | 5 | 2 | 3 |
| Hyde Park, | 13 | 5 | 8 |
| Kingston, | 1 | – | 1 |
| Lawrence, | 7 | 4 | 3 |
| Leominster, | 2 | 1 | 1 |
| Lincoln, | 1 | – | 1 |
| Lynn, | 100 | 41 | 59 |
| Malden, | 7 | 4 | 3 |
| Marblehead, | 3 | – | 3 |
| Marlborough, | 9 | 4 | 5 |
| Marshfield, | 1 | – | 1 |
| Medford, | 15 | 4 | 11 |
| Medway, | 15 | 9 | 6 |

TABLE I.— *Widal Test, Oct. 1, 1905, to Nov. 30, 1906, inclusive* — Concluded.

| CITY OR TOWN. | Number of Cases. | Positive. | Negative. | CITY OR TOWN. | Number of Cases. | Positive. | Negative. |
|---|---|---|---|---|---|---|---|
| Melrose, . . . . | 8 | 2 | 6 | Sturbridge, . . | 37 | 20 | 17 |
| Methuen, . . | 1 | - | 1 | Swampscott, . . | 4 | 2 | 2 |
| Middleborough, . | 1 | - | 1 | Taunton, . . | 13 | 6 | 7 |
| Middleton, . . | 2 | - | 2 | Topsfield, . . | 2 | - | 2 |
| Milford, . . . | 3 | - | 3 | Wakefield, . . | 2 | 1 | 1 |
| Millis, . . . . | 1 | - | 1 | Walpole, . . | 1 | - | 1 |
| Milton, . . . . | 10 | 3 | 7 | Ware, . . . | 1 | - | 1 |
| Natick, . . . . | 102 | 47 | 55 | Watertown, . . | 6 | 2 | 4 |
| Needham, . . . | 31 | 14 | 17 | Wayland, . . | 14 | 1 | 13 |
| Newbury, . . . | 1 | - | 1 | Wellesley, . . | 49 | 19 | 30 |
| Newburyport, . | 48 | 20 | 28 | Westfield, . . | 14 | 4 | 10 |
| North Adams, . | 2 | 2 | - | Westford, . . | 3 | 1 | 2 |
| Northfield, . . | 5 | 1 | 4 | Weston, . . . | 3 | - | 3 |
| Norwood, . . . | 8 | 5 | 3 | Westport, . . | 1 | - | 1 |
| Peabody, . . . | 7 | 1 | 6 | Weymouth, . . | 4 | - | 4 |
| Quincy, . . . | 3 | 2 | 1 | Williamstown, . | 5 | 1 | 4 |
| Randolph, . . . | 2 | 2 | - | Wilmington, . . | 1 | - | 1 |
| Reading, . . . | 13 | 4 | 9 | Winchester, . . | 12 | 2 | 10 |
| Revere, . . . . | 15 | 2 | 13 | Winthrop, . . | 7 | 3 | 4 |
| Rockland, . . . | 12 | - | 12 | Woburn, . . | 4 | 3 | 1 |
| Salem, . . . . | 6 | 3 | 3 | | | | |
| Saugus, . . . . | 4 | 2 | 2 | Total, . . . | 814 | 296 | 518 |
| Scituate, . . . | 6 | 1 | 5 | Cases reported as | | | |
| Shirley, . . . | 1 | - | 1 | "doubtful," . | 6 | - | - |
| Somerville, . . | 5 | 2 | 3 | | | | |
| Southborough, . | 1 | - | 1 | | 820 | - | - |
| Stoughton, . . | 5 | - | 5 | | | | |

TABLE II.— *Widal Test, according to Stage of Disease, Oct. 1, 1905, to Nov. 30, 1906.*

| APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD. | NUMBER OF CASES. | | APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD. | NUMBER OF CASES. | |
|---|---|---|---|---|---|
| | Positive. | Negative. | | Positive. | Negative. |
| 1, . . . . . . . . | - | 1 | 16, . . . . . . . . | 7 | 9 |
| 2, . . . . . . . . | 1 | 3 | 17, . . . . . . . . | 2 | 7 |
| 3, . . . . . . . . | 2 | 9 | 18, . . . . . . . . | 2 | 5 |
| 4, . . . . . . . . | 7 | 23 | 19, . . . . . . . . | - | 1 |
| 5, . . . . . . . . | 12 | 23 | 20, . . . . . . . . | 5 | 4 |
| 6, . . . . . . . . | 13 | 31 | 21, . . . . . . . . | 9 | 7 |
| 7, . . . . . . . . | 18 | 47 | 25, . . . . . . . . | 3 | 8 |
| 8, . . . . . . . . | 16 | 24 | 30, . . . . . . . . | 6 | 8 |
| 9, . . . . . . . . | 12 | 15 | 40, . . . . . . . . | 2 | 6 |
| 10, . . . . . . . . | 23 | 33 | 60, . . . . . . . . | - | 3 |
| 11, . . . . . . . . | 6 | 18 | 90, . . . . . . . . | - | 1 |
| 12, . . . . . . . . | 5 | 14 | Not stated, . . . . . | 114 | 175 |
| 13, . . . . . . . . | 6 | 8 | | | |
| 14, . . . . . . . . | 17 | 25 | Total, . . . . . | 296 | 518 |
| 15, . . . . . . . . | 8 | 10 | | | |

# MALARIA.

## MALARIA.

During the fourteen months ended Nov. 30, 1906, 22 blood specimens were received to be examined for the presence or absence of the malarial parasite. Of these, 3 were positive, 18 negative, and in 1 instance the preparation was so badly made that the examination could not be completed. The percentage of positive cases was 14.2. The following table shows the city or town from which the specimens, positive and negative, were derived: —

*Malaria, Oct. 1, 1905, to Nov. 30, 1906.*

| City or Town. | Number of Cases. | Positive. | Negative. |
|---|---|---|---|
| Bedford, | 1 | - | 1 |
| Everett, | 1 | - | 1 |
| Hull, | 1 | - | 1 |
| Melrose, | 1 | - | 1 |
| Newton, | 1 | - | 1 |
| Norwood, | 2 | 2 | - |
| Sheffield, | 1 | - | 1 |
| Stoughton, | 1 | 1 | - |
| Uxbridge, | 1 | - | 1 |
| Waltham, | 2 | - | 2 |
| Waverley, | 1 | - | 1 |
| Winchester, | 8 | - | 8 |
| Total, | 21 | 3 | 18 |

# REPORT

ON THE

# Sanitary Condition of Factories, Workshops and Other Establishments.

By the Secretary of the Board.

# Report on the Sanitary Condition of Factories, Workshops and Other Establishments.

By the Secretary of the Board.

In the course of the investigation of conditions affecting the health, safety or welfare of persons engaged in factories and other establishments, made by the State Board of Health, as directed by chapter 59 of the Resolves of 1905, more than 60 industries were examined. Attention was paid chiefly to those in which one or more of the essential processes involve exposure of the employees to possible unhygienic influences inherent to the industry.

The in-door occupations of chief sanitary interest are those which involve exposure to irritating and poisonous dusts; exposure to irritating, poisonous and offensive gases and fumes; contact with poisonous substances; extremes of heat and excessive dampness.

Of the several classes of dust, — those of vegetable, animal, metallic and mineral origin, — it is difficult to determine which is the most irritating to the respiratory tract; but the vegetable dusts are commonly so regarded, in spite of the well-known fact that the occupations in which the employees inhale minute particles of steel, glass and stone are remarkable for their high death rates from tuberculosis of the lungs. But not all of the dusts of one class are equally irritating; flax and cotton, for example, are more irritating than wood; steel is more irritating than brass; horn is more irritating than bone; granite is more irritating than marble, and glass far more than granite.

Workers exposed to dusty atmospheres are especially prone to diseases of the lungs, especially pulmonary tuberculosis, the constant irritation bringing about a condition of the mucous surfaces which more readily admits of invasion by the specific germs. Those who are exposed to poisonous dusts are, unless proper precautions are observed, likely to fall victims of chronic poisoning. The most dangerous of the metallic dusts met with in this investigation are those of lead and its compounds.

Of the various gases and fumes to which workmen are exposed, those which are merely irritating are of far less importance than those which are poisonous in their nature. The irritating fumes cannot be borne in

large amounts, and they cause the person exposed to seek the relief afforded by fresh air. In small amounts they cause slight tickling cough and perhaps catarrhs. Of the poisonous fumes, the most important and commonest met with in this investigation are those of naphtha and wood alcohol. Both of these substances are used in very many industries, as will be noted below. Naphtha fumes cause various forms of intoxication, especially in women. Among the symptoms are dizziness, nausea and vomiting, headache, hysterical phenomena, disturbances of the circulation and respiration, and mental confusion. In the periodical literature of industrial hygiene are not infrequently reported cases of fatal poisoning therefrom. Of equal or greater importance are the fumes of wood alcohol, which agent is very largely used, as a cheap substitute for grain alcohol, in varnishes, etc. Of late years it has become well known that, taken as a beverage, wood alcohol is likely to cause death, preceded by total blindness; but it is not commonly known that exposure to the fumes has caused many cases of serious impairment of vision and not a few of total blindness, due to action upon the optic nerves.

Offensive vapors and fumes may cause general disturbance of the digestive system and headache for a time in persons who are not habituated thereto; but as a rule tolerance is soon established, and they are not even noticed. In certain industries the raw materials are of an exceedingly offensive character, and give off at all stages of manufacture nauseous odors which the employees are compelled to breathe; these include the so-called offensive trades, such as soap making, glue making, tanning, rendering, etc. The noisome odors are an unavoidable feature of the business, and are popularly, but wrongly, regarded as conducive to the occurrence of infective disease.

In addition to inquiring into the measures adopted for the protection of the health of the employees against the inherent dangers of the various lines of industry, careful examination was made of the character and condition of the water-closets and washing facilities, of the provisions for rapid egress in case of fire, of the conditions as to general cleanliness and light, and of the extent to which the very dangerous habit of promiscuous spitting prevails.

In the report submitted in 1905 reference was made to the fact that the presence of consumptives in workshops constitutes a menace to the health of their associates, even though they may not be addicted to this habit. The reason lies in the fact that in their every act of coughing, sneezing and speaking, minute droplets of saliva, which may contain the specific bacilli of the disease, are sent forth into the air, in which they remain suspended for varying periods, to be inhaled perhaps by others. The spitting consumptive — and here it may be remarked that many a

person may be a victim of the disease for a long time before the fact becomes established by the usual diagnostic methods — is a far greater menace to the health of others, because his sputum, cast about upon the floor and elsewhere, becomes dried on exposure to the air, and then may be reduced to powder and sent in all directions through air currents or by dry sweeping and other mechanical means. It is a well-known fact that a very large proportion of deaths among those whose days are spent in in-door occupations is due to pulmonary consumption, and that this obtains in the highest degree in those industries whose followers are exposed to irritating dusts. In many of the reports which follow, mention is made of the extent to which the spitting habit was observed to prevail; where no comment is made, it may be understood that little or no spitting was noted.

With regard to light, it may be said that, although good light may not be a necessary factor in all of the various kinds of work, and poor light may not always lead to injury, the effect of well-lighted rooms, if only to exert an unconscious influence upon the minds and spirits of the workers, is highly desirable as a concomitant factor in the maintenance of health.

Reports on the individual industries investigated are submitted below, beginning with those in which the predominating inherent objectionable feature is dust, following by those which involve exposure to various gases and fumes, and concluding with several belonging to neither class. One of these is the public laundry business, in which there exists constantly the danger of possible exposure to infective matter from the bodies of the sick. The others are of constantly increasing public interest, respecting the possible insanitary influences to which the workmen are exposed, and unwholesome conditions to which our most important foods are subjected; these are baking and slaughtering.

The reports of the various industries in which dust is the predominating factor of importance are presented, according to the nature of the dusts, in the following order: vegetable, animal, mineral, metallic. Certain branches of the chemical industry in which there is exposure to dust will for convenience be taken up with the chemical industry as a whole, in which one meets with all kinds of dusts and fumes, and which, being more closely associated with the latter, whichever may be said to predominate, is presented after the dusty trades.

The examinations were not made by experts in the various lines of work, but by hygienists; and therefore, while the description of some of the processes may not be in all respects technically accurate, the statements as to hygienic conditions may be accepted as authoritative.

## The Textile Industry.

The textile industry in Massachusetts employs a larger number of persons in its factories than any other industry, and the majority of the employees are women and minors.

Its importance can best be comprehended by reference to the reports of the national census of 1900, wherein it is shown that the value of its products ($1,625,000,000) in the whole country is surpassed only by that of food products ($2,275,000,000) and of iron and steel ($1,790,000,000).

Massachusetts stands first in the production of both cotton and woolen goods, and in textiles as a whole. The value of her textile products in 1900 was $213,000,000; Pennsylvania stood second, with $157,000,000; and New York third, with $93,000,000. The value of her cotton products was $110,000,000, which surpasses by $5,000,000 the combined value of the cotton products of the four next important cotton manufacturing States, namely, South Carolina, North Carolina, Rhode Island and Pennsylvania. The value of the woolen goods produced in Massachusetts in 1900 is stated to be $73,500,000; Pennsylvania stands second, with $50,000,000; and Rhode Island third, with $39,000,000.

Official reports and scientific papers on the textile industries of various foreign countries have led to a general belief that the operatives engaged therein are exposed to such unhygienic influences as to warrant the classification of these industries among those which are especially inimical to health and longevity. It is a fact that dust from cotton and flax is particularly irritating to the respiratory passages, and that those long exposed thereto in considerable amounts may become more or less susceptible to infection by the exciting cause of tuberculosis. It should be borne in mind, however, that the character of many of the processes is such as to attract, here as elsewhere, large numbers of those of weak constitution and inferior development, who, whatever in-door occupation they may select, are least likely to oppose effective resistance to disease. In a previous report on industrial conditions in Massachusetts it was shown that a very large proportion of the decedent operatives in three mill towns of the State died of pulmonary tuberculosis and other diseases of the lungs; but further study of existing conditions compels a revision of opinions based upon the data then at hand.

Analysis of the death returns to the office of the Secretary of State during the year 1905, from the three principal "mill towns," shows that, although tuberculosis is one of the leading causes of death among mill operatives, the general death rate of this class was by no means abnormally high, being respectively 7, 8 and 10 per thousand. Tuberculosis

caused, respectively, 32, 23.57 and 21 per cent. of the deaths. It appears also that the general death rates of the cities whose populations include the highest percentages of textile operatives compare not unfavorably with those of certain other cities which are engaged in other kinds of manufacture or are more residential in character, in spite of the high rate of infant mortality which appears to be inseparably connected with mill populations everywhere.

The magnitude of the industry, the character of the conditions of operation, the sex and age of the majority of the persons employed, and the above-mentioned generally accepted opinion that those engaged in textile factories are exposed to exceptionally unhygienic influences, suggested the advisability of a particularly thorough study of the conditions obtaining in a large number of mills of various types, sizes and ages. Because of the great extent of the industry, it was impossible, with the force available, to visit every establishment, but in a number of the "mill towns" nearly all were studied.

### *Processes of Manufacture.*

For an adequate understanding of the possible unhygienic conditions to which the operatives may be exposed, a description of the various processes of manufacture is herewith presented.

*Opening the Cotton.* — Raw cotton is brought from the storehouse directly into the opening room or the picker room, according to the method of opening the bales.

One of the most modern mills visited has an opening room across the street from the mills. The cotton is opened and torn into small pieces by machinery, by means of a series of spiked aprons; then by conveyor belts, pipes and suction fans it is taken underground to the picker room in the mill, where, by a system of switches, it is dropped into the different bins ready for the first picker machine.

When the cotton is opened by hand, men take the bales to the cotton bins, where they break up the cotton into small masses, mixing the various grades as required.

*Picking.* — In the picker room, heavy machinery opens up the fiber, mixes it, beats it, cleans it, and delivers it in even sheets, or layers, known as "laps." The picker process varies somewhat, according to the class of work done.

The first picker machine is fed by a "feeder," which holds about 250 pounds of cotton. Usually one man attends five or six of these machines. The feeder ends of the machines are near the cotton bins, from which the man takes the cotton by armfuls, keeping the feed boxes filled.

*Work done by the Picker Machines.* — The picker machine may be a

"compound picker," which combines both opener and breaker, containing two "beaters." With this machine a large part of the cotton-seed and large cotton leaf is removed, leaving the cotton in the form of an even sheet or "lap."

The laps, weighing about 50 pounds each, are taken from the front of the "compound picker" by a workman, who places four of them on an apron of a "one-beater" picker, known as the "intermediate picker." He takes the laps from five or six of the first kind of pickers, and keeps the aprons of the intermediate pickers filled. The intermediate machines remove still more of the dirt and seeds, and are always to be associated with the English system of carding, mentioned below.

The cotton is now put through the "finisher" picker machines. These pickers remove the balance of the seed and large leaf; the small leaf is later removed by the carding process. The "laps" are now weighed, and, if found to conform to a certain standard, are taken to the carding room.

*Necessary Conditions in a Modern Picker Room.* — As cotton opens in the field it catches and holds much fine dirt, blown about by the winds; and when it is subjected to the treatment of the beaters in the picker machines, the dirt, bits of seed and leaf are forcibly separated. This material is not confined in the machine. By means of exhaust fans the cotton is drawn away from the "beater" and collected on a cage. The partially cleaned cotton comes out in front of the machines in the form of "laps," already described; while the motes and bits of leaf and seed, when separated from the cotton, fall to the enclosed space beneath the machines, from which the loose dust and sand are blown through pipes to a room called the dust room, which is connected with a large chimney. In spite of the well-constructed modern picker machines, a considerable amount of fine dust escapes into the workroom, — very slight, however, as compared with the amount which escapes from some of the older machines.

Fires are frequent in the picker rooms, but are seldom dangerous to the men employed. The precautions against loss of property, now generally taken, also protect the employees from injury.

The modern picker room is high studded, has several windows which admit sufficient light, and is equipped with incandescent bulbs or arc lights.

It is unnecessary to give much attention to the regulation of moisture in the picker room, except that excessive moisture must be avoided, lest the work may run badly in some of the later processes; hence, precaution is taken on damp days to prevent extra moisture getting into the room.

The services of but a few men are required in a picker room, and,

excepting the foreman, the men are of little or ordinary intelligence, the work being classed as "unskilled labor." In addition to tending the picker machines, it is the duty of these men to clean each machine several times a day. The work may or may not be constant. Generally the men known as "yard men," who unload the cotton, put it in tiers in the storehouse and take it to the picker room.

*Carding.* — From the picker room the cotton is taken in the form of cylindrical laps to the carding room, where it passes through the carding machines. Cotton-carding machinery has made great advances in recent years, and the best mills have kept fully abreast with the latest improvements. The laps are placed on a revolving-top flat card, which is an English type card (English or American make, but patterned after the original English card).

The carding machine cleans the cotton further by removing a certain amount of short fiber and leaf, the amount being governed by the adjustment or setting of the card. The adjustment is governed by the class of work; *e.g.*, in the manufacture of print goods, short, dirty cotton is used, while the fine goods mills use long-staple, high-grade cotton; and, in manipulating the latter, foreign substances in the cotton must be removed so far as possible. The amount of work on cards is also governed by the class of work, a small amount being put through the machines in the higher class. Thus it will be seen how, in the manufacture of print goods, with the use of short, lower-grade cotton, and with the large output per card, much more dust, dirt and lint arise from the machines than during the manufacture of fine goods, with the long-staple, high-grade cotton.

The carding machines subject the cotton to the action of cylinders covered with wire-toothed cards, revolving nearly in contact with each other, at different rates of speed or in opposite directions. Because of their construction, they permit some of the fine lint or "fly" to escape into the room, an amount at times sufficient to cause a distinct haziness of the air.

The operation of carding not only further cleans the cotton, but disentangles, straightens and parallelizes the fibers. The "lap" is first presented to a small cylinder called a "licker-in," which delivers to a much larger cylinder having fine wire teeth. Partly surrounding the larger cylinder are "flats," or a series of plane surfaces, also covered with teeth, which approach those of the cylinder as closely as possible without touching. Between the revolving cylinder and the flats the carding is effected; and the cleaned and straightened fibers are delivered to a third cylinder, called a "doffer," which "doffs" or strips off the cotton in the form of a delicate web. This web is then delivered to rollers,

which draw it through a funnel-shaped orifice in the form of a soft, narrow strand, in a loose, untwisted state, called a "sliver," which is introduced into a can by a coiler, which is also part of the carding machine. The work of the carding machine is now completed, although other processes are closely associated with carding.

In the medium or coarse goods mills the carding machines are generally found in one end of a long room, and the associated processes are followed in the other end, there being no partitions between the departments.

The employees in the card end of the room are adult men; while those in the other part, on work to be described later, are women.

Since the amount of cotton dust thrown out into the room by carding machines is greater in proportion to the amount of low-grade cotton used and the large output per card, it follows that all of the operatives in such rooms are exposed to considerable cotton dust, although the men attending to the cards are subjected to the greatest quantity. In some of the coarse-goods mills the carding room contains carding machines only. These rooms are exceedingly dusty.

The men employed include both "skilled" and "unskilled help." They put the "laps" in the back part of the card, and clean the cards, both inside and out, several times a day. The sliver in cans is carried away by the can boys.

The greatest amount of dust comes from the cards when the men remove the waste from the cylinders. The short, broken fibers are again stirred up by sweeping the floors from time to time, by cleaning the shafting and pulleys and by brushing the walls, thus giving rise to an extra amount of cotton dust or "fly" in the air of the room. The men work in this room throughout the day, averaging fifty-eight hours per week.

Extremes of heat or moisture in the carding room would interfere with the work either in the carding process or in some of the later processes. Some of the mill men introduce artificial moisture in the carding rooms; others do not, on the ground that there is sufficient natural moisture in the cotton. Very moist air, on the other hand, would cause the cotton to stick to some of the machinery; moreover, it would cause the delicate web which comes out of the front part of the card to sag or break down. Another condition which, it is claimed, interferes with the work, is the existence of strong air currents, which would readily disturb, if not destroy, the delicate web.

Considering these conditions from a hygienic point of view, it may be said that a carding room with either excessive heat or excessive moisture is seldom found. The practical questions to be met in the carding

room are two, viz.: (1) how to diminish substantially the amount of dust in the room; and (2) how to ventilate the room properly, — both to be accomplished in old mills, with "reasonable" expenditure. Emphasis is laid upon "old" mills, for the reason that in these the rooms are commonly low studded, with small windows, and devoid of modern means of ventilation and heating. The modern card room is very large and high studded (*e.g.*, 15 feet), with good-sized window glass, and transoms which are easily opened; it is well lighted with arc or incandescent lights, and is heated and ventilated by modern means. In some of the rooms are two or more large exhaust fans. The ceiling and walls are clean and white, and the floor is kept reasonably clean during working hours.

*Drawing and Combing.* — The cans of loose, untwisted cotton, or "sliver," from the carding machines are now ready for the next process. In the manufacture of plain cotton cloth of medium weight, this process, called "drawing," results in combing several strands into one, and attenuating these more and more by repeated operations of the same sort. If, on the other hand, a high-priced and extra quality of yarn is to be spun, the "sliver" goes directly from the cards to the combing machines, after first being prepared for the combers by a series of doublings and drawing on the "sliver" and "ribbon lap" machines. This work preparatory to combing is usually done by young men.

In the process of combing the short stock and foreign substances are removed from the cotton, the quantity of which is governed by the class of work the particular mill is running. Cotton-combing manipulates the fiber so thoroughly that the proportion of waste is large. It leaves the fibers more nearly parallel than in the carded sliver. In some cotton mills equipped with the latest patterns of combing machines all of the yarns are combed as well as carded.

The combing process is more satisfactorily followed in a room entirely separate from the carding machines, since the combers are delicate machines, requiring fine adjustment, and the presence of much dust in the air of the room interferes with the work. For this reason a glass partition, which separates the cards from the delicate combing machinery, has been erected in a number of carding rooms.

The employees engaged in the combing department are women. Their duties are to keep the machines supplied with laps; to remove the product, which is in the shape of slivers coiled into cans; and to keep the machines as clean as possible. The work, while not hard, requires constant attention. The women are notified and drilled not to clean the machines when in motion; but, in spite of this discipline, a considerable number of injuries occur. The type of injury is the mutilation or severing of

fingers or hands by the series of strips of needles in the combing apparatus. The product is taken by girls, or comber tenders, to the drawing hands, to be passed through the drawing frames.

The principal mechanism of a drawing frame consists of three or four pairs of rollers, which grip the sliver tightly, and successively revolve at higher speeds. Thus six strands of sliver are united and drawn into one, smaller than any one of the six, and much more even. Two or three of these drawing frames are used; the second receives the product of the first, and so on. The employees are mostly young men. They keep the material going through the back of the machines and remove it from the front; they also keep the machines oiled and clean.

*Roving.* — Roving is an intermediate process between combing and spinning. The sliver of cotton has become so small that it must be twisted in order to bear handling; and the machines (usually three) which draw, twist and wind it upon bobbins into a soft, loose cord, ready for the spinner, are called "roving frames." The first is usually known as the "slubber," the next as "intermediate" (in fine-goods mills there is a second intermediate) and the third as a "fine frame;" and each successive machine gives a finer product, more nearly approximating yarn or thread, and operates at a higher speed. The slubbers (first process of roving) are generally operated by men. The product of the slubbers is handled by both men and women, while the rest of the work is generally run by women. The employees are required to keep the machines cleaned and oiled. The work previous to roving is "standing work;" that of the roving processes permits of intervals for sitting down. In some mills special seats are provided for the women employees.

The "fine roving" is the last process of the carding department.

The best results, from a commercial point of view, are to be obtained only by providing suitable atmospheric conditions as to heat and moisture in every room, beginning with the picking; but attention to these conditions is vital in roving and the later processes of spinning and weaving. Yarn produced in a room in which the temperature is allowed to fall too low and the air to become too dry is weak, uneven and covered with protruding fibers which are rubbed off in later processes; thus the quality of the yarn or of the cloth into which it enters is very much lowered.

*Ring Spinning.* — The roving, having been reduced to a suitable size for the intended "number" of yarn, now goes to the spinning machine, which may be either a "ring frame" or a "mule;" the ring frame being generally used for warp and the mule for weft yarn or "filling," although either machine is occasionally employed for both purposes.

The principle of the spinning machine is the same as that of the rov-

ing frames, though the mechanism employed is very different, and operates at much greater speed, the spindle generally revolving at from 6,000 to 10,000 turns per minute. The roving is again elongated by drawing rollers to an extent depending upon the size of the yarn desired; and the fully twisted thread is wound upon bobbins or tubes by rotating on the rapidly revolving spindles. The operations of the ring-spinning frame are continuous.

The temperature must at all times be sufficiently high to keep the steel rolls, through which the fine threads of cotton are drawn, warm enough not to cause the cotton to wind around the rolls instead of passing through them. The heat generated by the friction of the machinery in a ring-spinning room is at least sufficient to keep the room at a good spinning temperature in the winter months, provided the room is at a proper temperature on starting the mill in the morning.

By means of humidifiers, properly installed and rightly cared for, the amount of artificial moisture admitted into spinning rooms can generally be satisfactorily regulated, so that in some mills the unhealthy and objectionable system of "steaming" (steam vapor pot system) is abandoned.

The rapidly revolving spindles give rise to considerable cotton dust in the air of a ring-spinning room, in the form of fine, broken fibers, although the amount of dust is very small as compared with the quantity present in a carding room.

The employees are mostly boys and girls and women. The spinners place the roving in creels, piece up the ends when the thread breaks and doff the bobbins when full; they also keep their frames clean. The work requires neither especial intelligence nor unusual physical strength, nor does it demand constant attention. The spinners frequently find opportunity to sit. In some coarse work the spinners both spin and doff, and are, therefore, required to watch the work frequently; while in certain grades of work some young persons are employed solely for "doffing," and have a definite number of spindles to doff per week. In this case the "doffers," after doffing all the spinning frames, may leave the room until it is time to fill the frames again. Men look after the spinning frames, make changes and repairs, lay the roving on the creels and take care of the yarn after it is doffed.

Except for the continuous noise of the machinery, which is very great, but in an uninterrupted, unvarying tone, and for the loose cotton dust in the air of the room, the spinners in a modern, well-regulated, ring-spinning room work under favorable conditions. Such a room is well ventilated; properly heated; has large windows and transoms, which open; clean walls and ceilings; and is lighted by incandescent bulbs.

*Mule Spinning.* — In many mills the filling for the cloth is spun on frames called "mules." The operations of the mule-spinning frames are intermittent, the spindles being mounted in a travelling carriage which backs slowly away from the drawing rolls as the spinning proceeds, and then returns to wind a length of completed yarn; thus the process is repeated. The roving passes through the steel rollers as in ring spinning, but is drawn out about 60 inches by the travelling carriage before it is wound on the spindles.

Because of the long stretch covered by the travelling carriage, and since the filling has less twist than the warp, an extra amount of moisture in the air is necessary to prevent the ends from breaking.

The air in mule-spinning rooms is very warm and moist at all seasons of the year. In the winter months the thermometer registers between 80° F. and 100° F., varying according to the class of work and the care and method of regulating the heat and moisture.

The employees in "mule" rooms are all males; the spinners are men and the helpers are boys.

The men (spinners) must walk to and fro, following the movements of the "carriage," which is constantly moving backwards and forwards, and looking after the piecing of broken ends and the adjustment of the mule.

Much greater intelligence is needed in mule spinning than in ring spinning. In mule spinning, also, the spinner must pay close attention to his work, which, however, is not necessarily trying, under good conditions. The good mule room, like the good ring-spinning room, is well lighted and ventilated.

The boys are not constantly employed, but they are confined during the regular working hours, in order to be ready to doff the mule frames, which, unlike ring-spinning frames, are doffed at irregular periods. The boys place the roving in the creels, assist the spinners in doffing the full "cops" (*i.e.*, the conical masses of coiled yarn wound on spindles), and take the empty bobbins back to the card room. They keep the "carriage" clean by running their hands along it to take off the lint and dust which collect during the process of spinning. It is their duty to sweep the mule room floors two or three times a day.

Because of the high temperature in mule rooms, the men remove their outside clothing and wear undershirts and overalls, while the boys wear short trousers. Generally the men and boys go about the rooms barefooted, although some wear sandals, slippers or old shoes.

*Spooling and Warping.* — After the yarn has been spun it is prepared for the looms by the use of three consecutive machines, which form a part of one system. The first machine, the "spooler," transfers the yarn

from the small bobbin on which it is spun to a large spool holding so many yards that the next machine, the "warper," will not have to be stopped to piece ends. The first machine also passes the yarn through a fine slot in the guide which leads it to the spool, in order to detect bunches or weak places, either of which will break the yarn at the guide. The defects are removed, and the sound yarn is tied to make a continuous strand.

The next machine, the "warper," prepares the yarn for the process of "dressing." A number of large spools filled with yarn from the spoolers, usually between 300 and 400, are put into a frame or "creel," and the threads are brought together into a sheet and delivered between guides, which space them at equal distances, then passed through mechanism calculated to stop the machine if a thread breaks, and led to and wound upon a large beam, called a "section beam," in order to get as much length as possible.

In the spooling and warping room a few fine fibers of loose cotton become detached from the threads as they are wound from bobbin to spool and from spool to beam.

The employees in the spooling and warping department include men, who place the bobbins on spooling frames; "spooler girls," who vary in age from young girls to middle-aged women; and warper tenders (girls), who mend broken ends. These girls find considerable time to sit, depending upon the frequency of the breaking of the ends. Some mills employ a few girls solely for the purpose of tying in the threads for the warping frames. The work of the "spooler girls" is constant, but not difficult.

*Dressing or Slashing.* — The section beams, having been filled at the warper, are arranged at the dressing machine or "slasher" in groups of four to eight, as may be required to furnish sufficient threads for a single warp. After the beams are placed in position at the back of the "slasher," the yarn is passed through a vat containing a sizing compound of hot starch, and then through squeeze-rolls to expel the superfluous starch. Squeezing the thread between rollers helps to fill the body of the thread with starch or "size."

After leaving the rolls, the sheet of yarn passes around large drying cylinders, made usually of copper, and filled with steam. One cylinder is placed in front of the other, the larger being about 7 feet in diameter and the smaller about 5 feet, each having a face of about 60 inches.

From these cylinders the yarn passes through "lease rods," to prevent the threads from sticking to one another, and is finally wound on the "loom beam."

A less common form of "slasher," instead of carrying the yarn over

drying cylinders, is supplied with a closed box heated by steam pipes, in which a circulation of air is maintained by a fan, and through which the yarn passes to be dried.

Men are employed to run the slashers. The heat from the machines is considerable, and the men wear only undershirts, drawers and overalls; they do not go barefooted, as in the mule room. The work in this department is heavy and constant. Whatever dust appears in the air of the room is mainly small particles of starch.

*Drawing-in.* — The next operation in preparing the starched or "sized" warp for the loom is "drawing-in," which has until lately been wholly performed by hand. This process can hardly be intelligently described without at the same time considering the loom and its operation. For the loom to fulfill its function of interlacing warp and weft threads to form the usual continuous fabric, every alternate warp thread must be raised and the others depressed, while the weft or filling thread is passed across in the opening so made; after which the position of the warp threads is reversed, and the weft again thrown across. During the time occupied for reversing the position of the warp threads, the weft thread is beaten firmly and closely up against the one preceding it.

To raise and depress the warp threads alternately requires that they be drawn into the eyes of a "harness." A pair of parallel bars, holding cords stretched between them, each cord having an eye in it through which a warp thread is passed, serves to raise one-half the threads, while a similar apparatus depresses the rest; this forms the harness. All the warp threads, usually by twos, are then passed between short upright wires, closely set in a frame, which forms the "reed;" and, the weft thread crossing the warp in front of the reed, a forward motion of the latter beats it to place, as described.

For convenience, in the order of processes, the "drawing-in" apparatus is always near the slashers. When the slashing and drawing-in departments are in the same room, the warps from the slashers are taken to the drawing-in frames, which are invariably situated within a few feet of the windows, in order to secure the best light in the room for the "drawing-in girls."

A full warp beam is placed on an iron frame in front of a "drawing-in girl," who sits a few feet from a window, the light passing over her shoulders. The harness and reed are hung on the frame in front of her, and her work is to draw the warp threads in proper sequence through the eye of the harness and the spaces of the reed. The warp then goes to the loom.

The work is more or less trying to the eyes, but the best light available is given this department. The girls sit at their work, which is "piece work," and they sometimes continue working during a part of the noon

hour, although contrary to the law and the printed notices posted in the room.

*Weaving.* — The warp, sized, wound on a beam and "drawn-in," is placed at the back of the loom; the harness and the reed are fixed in their proper places; suitable mechanism releases the warp and winds the cloth as the shuttle containing the weft crosses and re-crosses, and the reed is carried forward to beat each weft thread to place. No such preparation is required for the weft, or filling thread, as is given the warp. Usually it comes directly to the loom from the ring or mule spinning frame on which it is spun.

Both adult men and women work in the weave room; occasionally a few young persons.

As mentioned under roving, the provision for a suitable temperature and humidity are necessary for the best work. Especial attention is required in regulating the humidity during the prevalence of cold, dry weather, with high winds.

About the loom is more or less fine dust (starch and lint), which chafes off the warp threads as they pass through the harness and reed.

A small proportion of the men in a weave room are "loom fixers," who put warps into the looms, hang the harnesses and get the looms ready for weaving. They also make necessary repairs on the looms.

A weaver (man or woman) attends four, six, eight or more looms, according to the kind of work and the kind of loom. The weaver's duties are to put the cop into the shuttle, which is placed in the loom; to mend any broken warp threads; to observe all imperfections in the yarn, and to prevent them from weaving into the cloth. Each weaver keeps his looms oiled and cleaned.

More intelligence is required of an employee in a weave room than in any other department of a cotton mill; while that part of the work done by the "loom fixer" takes considerable physical strength.

Weaving necessitates constant attention, although the weaver finds time to sit at intervals.

The finer and more ornamented the fabric is woven, generally speaking, the more care and skill are demanded in the weaver. Some kinds of work require great strength and endurance; some kinds are repugnant, because of the conditions under which the work must be done, as in weaving dark-colored fabrics, or when dust arises from dyestuff or from shoddy; some kinds demand an unusual degree of perfection in the product, calling for constant and minute attention.

Thus it is clear that not only good light, evenly distributed, is a reasonable requirement in the weave room, but that good ventilation and proper regulation of heat and moisture are also hygienic essentials.

Finally, should be mentioned the monotony of tending the machine

day in and day out, the roar and buzz and the sharp, jerky noise of the machinery, which is deafening, and, to those particularly sensitive, "nerve-racking."

A bad, unhygienic habit, common to all weavers who tend old-fashioned looms, is that of drawing the filling through the shuttle eye with the mouth. The weaver puts his mouth close to the shuttle, and, by means of a quick intake of breath, sucks the end of the thread through the shuttle eye, thus drawing into his mouth more or less fine lint and dust, which gives rise to spitting, and sooner or later may cause irritation of the mucous membrane of the throat. This practice is especially bad because of the fact that, if out for a day, a spare hand substitutes. The so-called Northrup loom is gradually replacing the others. In this loom, after the drum is filled with shuttles, the action is entirely automatic.

### *Mills visited.*

Ninety-three manufacturing establishments, comprising several hundred mills, were visited. In the list which follows, C indicates cotton; D, dyeing; K, knit goods; S, silk; and W, woolen or worsted.

| City or Town. | Name of Company. | Character of Product. | Number of Employees. |
|---|---|---|---|
| Billerica, | Faulkner Manufacturing Company, | W | - |
| | Talbot Mills, | W | 400 |
| Cambridge, | American Net and Twine Company, | C | 350 |
| Chicopee, | Dwight Manufacturing Company, | C | 1,700 |
| | Chicopee Manufacturing Company, | C | 1,300 |
| Clinton, | Lancaster Mills, | C | 2,000 |
| Fall River, | Algonquin Printing Company, | D | 350 |
| | American Linen Company, | C | 1,000 |
| | American Printing Company, | D | 925 |
| | American Thread Company (Kerr Mills), | - | 1,000 |
| | Arkwright Mills, | C | 500 |
| | Barnaby Manufacturing Company, | C, S | 550 |
| | Barnard Manufacturing Company, | C | 650 |
| | Chace Mills, | C | 650 |
| | Conanicut Mills, | C | 175 |
| | Cornell Mills, | C | 400 |
| | Davis Mills, | C | 400 |
| | Durfee Mills, | C | 1,125 |
| | Fall River Bleachery Company, | D | - |
| | Fall River Iron Works Company, | C | 5,000 |

| City or Town. | Name of Company. | Character of Product. | Number of Employees. |
|---|---|---|---|
| Fall River — *Con.*, | Fall River Manufactory (see Pocasset Manufacturing Company). | C | 350 |
| | Flint Mills, | C | 425 |
| | Globe Yarn Mills, | C | - |
| | Granite Mills, | C | 1,200 |
| | Hargraves Mills, | C | 900 |
| | Kerr Mills, | C | 1,000 |
| | King Philip Mills, | C | 1,100 |
| | Laurel Lake Mills, | C | 564 |
| | Mechanics Mills, | C | 600 |
| | Merchants Manufacturing Company, | C | 1,350 |
| | Parker Mills, | C | 350 |
| | Pocasset Manufacturing Company, | C | 750 |
| | Sagamore Manufacturing Company, | C | 800 |
| | Sanford Spinning Company, | - | - |
| | Seaconnet Mills, | C | 380 |
| | Shove Mills, | C | 700 |
| | Stafford Mills, | C | 800 |
| | Stevens Manufacturing Company, | C | 500 |
| | Union Cotton Manufacturing Company, | C | 900 |
| | Wampanoag Mills, | C | 800 |
| Fitchburg, | Grant Yarn Company, | C | 250 |
| | Nockege Mills, | C | 250 |
| | Orswell Mills, | C | 350 |
| | Parkhill Manufacturing Company, | C | 1,150 |
| Haverhill, | Stevens & Company, | W | 185 |
| Holyoke, | Farr Alpaca Company, | - | - |
| | Lyman Mills, | C | 1,800 |
| Lawrence, | Arlington Mills, | C, W | 800<br>3,500 |
| | Atlantic Cotton Mills, | C | 1,200 |
| | Everett Mills, | C | 1,000 |
| | Kunhardt, G. E., | W | 950 |
| | Lawrence Duck Company, | C | 800 |
| | Pacific Mills, | C, W | 5,200 |
| | Pemberton Company, | C | 750 |
| | Washington Mills, | W | 6,500 |
| | Wood Worsted Mills, | W | - |
| Lowell, | Appleton Company, | C | 1,100 |
| | Bay State Mills, | W | 600 |
| | Boott Cotton Mills, | C | 1,400 |

| City or Town. | Name of Company. | Character of Product. | Number of Employees. |
|---|---|---|---|
| Lowell — *Con.*, | Hamilton Manufacturing Company, | C, D | 2,500 |
| | Lawrence Manufacturing Company, | K, D | 3,700 |
| | Lowell Bleachery, | D | 350 |
| | Massachusetts Cotton Mills, | C | 2,300 |
| | Merrimack Manufacturing Company, | C, D | 3,000 |
| | Middlesex Company, | W | 600 |
| | Stirling Mills, | W | 190 |
| | Tremont and Suffolk Mills, | C, W | 3,000 |
| Ludlow, | Ludlow Manufacturing Associates, | - | - |
| Methuen, | Methuen Company, | C | 350 |
| Millbury, | Cordis Mill, | C | 150 |
| | Mayo Woolen Company, | W | 200 |
| | Rice, E. F., | C | - |
| | U. S. Linen Company, | - | - |
| | West End Thread Company, flax, | - | - |
| New Bedford, | Bennett and Columbia Spinning Company, | C | - |
| | Grinnell Manufacturing Company, | C | 1,050 |
| | Manomet Mills, | C | 500 |
| | New England Cotton Yarn Company, | C | - |
| | Pierce Mill Corporation, | C | - |
| | Potomska Mills, | C | 1,200 |
| | Rotch Spinning Corporation, | C | - |
| | Soule Mill, | C | 700 |
| | Wamsutta Mills, | C | 2,200 |
| | Whitman Mills, | C | 1,500 |
| Newburyport, | Peabody Manufacturing Company, | C | 150–500 |
| North Andover, | Brightwood Manufacturing Company, | W | 300 |
| | Osgood Mills, | W | 100 |
| | Sutton Mills, | W | 175 |
| Readville, | Readville Cotton Mills Company, | C | 200 |
| Salem, | Naumkeag Steam Cotton Company, | C | 1,500 |
| Saxonville, | Saxonville Mills, | W | - |
| Taunton | Canoe River Mills, | C | 150 |
| | New England Cotton Yarn Company (No. 2 Mill), | C | - |
| Waltham, | Boston Manufacturing Company, | C | 1,100 |
| | Waltham Bleachery, | - | - |
| Worcester, | Daniel's Worsted Mill, | W, D | - |
| | Wachusett Thread Company, | C | 150 |

Of these 93 manufacturing establishments, 19 carry on their manufacture under nearly ideal conditions, and 23 under conditions which may be designated as good. The condition in all of these, including, as they do, nearly half of the number of establishments and much more than half of the number of operatives employed, and the condition of the health of those employed, as determined by their appearance, the testimony of the physicians prescribing for them and the vital statistics of the cities and towns where located, raise the hygienic condition of those employed far above "the most unhealthy classes of wage earners," with which hygienists have been wont to associate textile workers, even to a very favorable position among wage earners who are congregated in large numbers within doors.

It would be a source of great gratification if the condition of the minority be raised to so satisfactory a standard. Of these, moderately bad conditions were observed in 35 and distinctly bad in 16 establishments. In all of the two latter classes it seems possible to secure marked improvement in conditions, with not unreasonable expenditure.

In order to make a fair comparison of the mills, the various grades of stock used by different corporations and the age of the buildings have been considered. A study of 12 corporations using fine grade of stock shows that 8 of this number have mills whose conditions are very nearly sanitarily ideal, although some of the buildings are from twenty-five to fifty years old.

Of 15 corporations using medium-grade stock, 2, started in recent years, have buildings which are lacking in general order and neatness, while 5 have buildings, varying in age, in which the conditions are good. Of 5 corporations manufacturing colored goods, the buildings of 1 corporation, erected between 1849 and 1892, show nearly sanitarily ideal conditions; while buildings of another of these corporations, erected about twenty-five years and one year ago, are in very satisfactory sanitary condition. Thus it is seen that some of the oldest mills have not only good but very nearly ideal sanitary conditions.

The conditions in coarse-goods mills are less frequently found to be satisfactory. Of 27 corporations using mainly coarse cotton, 5 have buildings in which the hygienic conditions are satisfactory, while the mills of 13 corporations show moderately bad conditions, and those of 9 corporations have conditions which are distinctly bad.

Illustrations are given below of the various types of mills in which the conditions are moderately bad or distinctly bad, to show the lack of general sanitation, — conditions which can be improved with reasonable expenditure, — and of those in which the conditions are excellent or good.

First, however, are submitted certain facts concerning conditions which may affect the health and well-being of mill operatives:

*Conditions as to Light, Heat, Dust, Humidity, Gases, etc.*

Poor light is itself a factor of no mean consequence in reducing the physiological resistance to disease. It may be a concomitant of a number of other unsanitary influences which affect the health of the worker, as, for example, in the weaving and spinning rooms; or it may be the principal factor, as in web drawing. Apparently too little thought has been given, in mill construction, to providing for light in accordance with the kind of work to be done in a given room. Many rooms are of old construction, with comparatively low ceilings, small windows and small panes of glass. Some of these rooms are narrow, and admit fair light from the sides; but some are wide, and some are basement rooms, which lack both an ample supply and an even distribution of light.

Aside from the question of mill construction, two important factors contribute to poor light in a large number of rooms, viz.: (1) neglect to keep the ceiling and walls clean and white; and (2) infrequent washing of windows, allowing them to go unwashed in some instances for several years. It is frequently the case that prismatic glass of different kinds and sizes is introduced into poorly lighted rooms; but unless this glass is kept reasonably clean, it is of little value. In poorly constructed and neglected rooms, with or without prismatic glass, artificial light is not uncommonly used even on bright, sunny days in the late morning or early afternoon hours; and in such rooms gas jets are as likely to be found as incandescent bulbs. Even if artificial light is not used until the late afternoon hours, there is then much variation as to the time and method of lighting and the kind of light in use. In some instances the light should be turned on half an hour, or longer, before the engineer sees fit to do so; yet the employees during this time are supposed to continue their work with the same degree of accuracy and rapidity as with good light.

The following kinds of light have been met with, and are recorded in the order of frequency: (1) incandescent bulbs; (2) arc lights; (3) gas jets; (4) mercury vapor lights and electric bulbs; (5) kerosene lamps.

It is a well-established fact that either the over-use of the eyes, or the use of eyes under bad conditions, may give rise to eye fatigue or to eye strain; and many eye specialists believe that at least 80 to 90 per cent. of headaches are dependent upon eye strain.

With these facts in mind, it is impossible to ignore the probability that many individuals working by gaslight, or even electric light, in dirty, unpainted, overheated rooms, with impure air and excessive moisture,

for ten hours a day or merely for the last two hours during the day, use up a great deal of nervous energy, and suffer from eye fatigue, or eye strain, and its consequences.

In the weaving and spinning departments there are two distinct causes of possible injury to the employees, viz., (1) insufficient light and (2) dust.

Some employees may be exposed to both sources of injury, although it is not usual to find much dust in a weave room. The department where reasonably good light is important, in which most commonly there is considerable dust, is that of ring spinning. Here, on account of the character of the machinery and the way in which it is placed, there are very commonly dark alleys, so that the work of "finding the ends" becomes somewhat trying to the eyes, particularly in rooms that are poorly lighted.

In both weaving and spinning departments there are a number of other unsanitary influences which may affect the health of the workers, the effects of any one of which are not susceptible of correct measurement. The spinning rooms are often excessively hot; the temperature in the winter months is commonly above 90° F., and occasionally above 100° F. The heat generated by the friction of the machinery in a ring-spinning room is at least sufficient to keep the room at a good spinning temperature in the winter months, provided the room is at a proper temperature on starting in the morning.

Although in the majority of the ring-spinning rooms some means of introducing artificial moisture is adopted, the methods of introducing the moisture vary considerably, while in some rooms no artificial moisture is introduced. In a considerable number of spinning and a large number of weave rooms the means of introducing moisture is by the old steam vapor pot, which many agents say is a detriment to a mill, both because it permits excessive steam and heat, and because the regulation of humidity is practically impossible. In addition, therefore, to poor light and some dust in many of the weave rooms and to considerable dust and poor light in many of the spinning rooms, there is commonly an excess of moisture with unnecessary heat in weave rooms, and excessive heat with frequently undue moisture in spinning rooms. Some spinning rooms have no means of artificial moisture; the air in these rooms is, as a rule, very dry.

A weave room with poor light, unnecessarily high temperature, with some dust and an excess of moisture, is not, from a sanitary point of view, a desirable room to work in; neither is a spinning room with considerable dust flying about, together with excessive heat and either undue moisture or no artificial moisture whatever. Add to these unhygienic influences two prominent factors which enter into health conditions of

both weave and spinning rooms, viz., (1) want of cleanliness and (2) lack of provision for a plentiful supply of fresh air, and a class of rooms is represented which is conspicuously common among the weave and spinning mills in this State.

The conditions found in a certain proportion of weave and spinning rooms may be tabulated as follows: —

1. Poor light.
2. Presence of carbon dioxide and carbon monoxide in the air.
3. Non-regulation of artificial moisture: (*a*) excess of moisture, undue heat; or (*b*) no artificial moisture, excessive heat.
4. More or less dust ("fly," dust from sizing, etc.).
5. Lack of cleanliness.
6. Lack of provision for a plentiful supply of fresh air.

A study of 14 corporations whose rooms were decidedly lacking in general order and neatness shows the above conditions in the weaving and spinning departments in their comparative relations: —

| Poor Light. | Products of Gas Combustion. | Excess of Heat or Moisture. | Dust. | Want of Cleanliness. | Lack of Proper Ventilation. |
|---|---|---|---|---|---|
| 14 | 6 | 12 | 14 | 14 | 14 |

A similar relation holds with reference to the factors mentioned above, 1, 2, 3, 4 and 6, in a considerable number of rooms in which the general order and neatness is "fair" or even "good."

The presence of dust in the air of workrooms is a prominent feature in its influence on health. Aside from dirt and other impurities which may be in the stock, it is the opinion of recognized medical authorities that vegetable dusts are markedly inimical to health. Those operatives in cotton mills who are peculiarly sensitive to unhygienic influences may become seriously affected through the constant irritation of cotton dust or "fly" in the upper air passages, giving rise first to dryness of the throat and later to cough and expectoration. Flax dust is thought to be even more irritating than cotton, while dust in the woolen and silk mills (animal origin) is considered to be less harmful in its effects.

There are many departments in which processes are conducted which expose the employees to dust; but the weaving, spinning, carding and waste rooms illustrate the important unhygienic conditions commonly associated with this disturbing element. In estimating the effects of dust upon health, the following considerations, among others, are to be borne in mind: —

1. Grade of stock used, *e.g.*, quality of cotton.
2. Quantity of dust in a given room.
3. Whether the dust is constant.
4. Type of construction of the room.
5. System of management.
6. Number and kinds of other unhygienic influences present.
7. Means of ventilation.
8. Health and susceptibility of the individual.

In some weave rooms the air is so filled with minute bits of dust as to present a hazy or "smoky" appearance throughout the room, and parts of the room are covered with the small particles which have settled thereon; while other weave rooms are practically free from such dust, there being merely a slight amount of lint or dust of microscopic fineness.

Dust in ring-spinning rooms is more constant and is greater in amount than in weave rooms. In a fine-goods mill, in which a high quality of cotton is used in a properly constructed and well-regulated room, the amount of dust present is comparatively unimportant, from the point of view of health. On the other hand, in a coarse-goods mill, where waste stock is used in a low-studded and generally neglected room, the amount, constancy and character of the dust is such as to suggest the probability of real danger.

While in both weave and ring-spinning rooms there are many unhygienic factors, the principal features of the card room are (1) the amount of dust and (2) lack of proper ventilation and effective means of removing the dust. Cotton dust in the card room varies greatly both in quality and quantity. It is always considerable, owing to the carding process of freeing and cleaning the material. In some mills it is enormous in amount, with considerable dirt as a concomitant. The quantity of dust is commonly sufficient to cause a distinct cloudiness of the atmosphere, which, in a room lacking proper ventilation, is a serious menace to the health of the operatives.

In the assorting or waste room "sweepings" are picked over and the different grades separated. Here may be found numerous kinds of waste and dirt, including that which comes from the floors of the card and spinning rooms, and, of most importance, sputum in large quantities, which may contain the exciting causes of infective diseases of the respiratory tract.

It has long been known that work which involves more or less constant confinement in a dusty atmosphere predisposes to the development of diseases of the lungs, especially of pulmonary consumption; but only in

recent years, through the science of bacteriology, has the medical profession and the public been enlightened as to the specific cause of consumption, and the method of its dissemination among the susceptible. The people of to-day, therefore, in every walk of life, have a far greater responsibility thrust upon them with respect to minimizing this source of danger by the application of all reasonable sanitary measures. We have to bear in mind, then, in considering the dust problem, the possibility of the presence of "infectious dust" from dried sputum in the air of different mill rooms. Persons suffering from consumption cannot always be detected in these rooms, and the habit of indiscriminate spitting involves the possibility of infection.

A comparison of the important constant or possible unhygienic influences in the ring-spinning and carding departments, with emphasis upon the dust in these rooms, is as follows: —

*Ring Spinning.*

1. Considerable dust (constant).
2. "Infectious dust" (dried sputum).
3. Excessive heat (with artificial moisture).
4. Excessive heat (without artificial moisture in some rooms).
5. Lack of provision for a plentiful supply of fresh air.
6. Poor light.
7. Carbon monoxide gas, and excessive amounts of carbon dioxide from respiration and combustion.

*Carding.*

1. Dust (abundant and continuous).
2. "Infectious dust" (dried sputum).
3. Lack of provision for a plentiful supply of fresh air.
4. Carbon monoxide gas, and excessive amounts of carbon dioxide from respiration and combustion.

Having considered some of the larger workrooms with especial reference to insufficient light and to the presence of dust, together with other unsanitary influences, attention should be called to the facts concerning the introduction of artificial moisture.

A special study of 80 weave rooms was made. In 57 of these rooms the so-called steam vapor pot[1] system was found. In 18 rooms there was excessive moisture; in 4 of these, excessive heat. In 20 rooms the drosophore or some other modern system (with or without the vapor

[1] By this system moisture is usually added to the air of the rooms by means of a number of steam jets. Steam thus introduced is known in the trade as "live steam." The moisture becomes visible just after escaping from the pipe, and again disappears at a distance of 2 or 3 feet.

steam) was found, showing that the modern systems are fast gaining ground. In 9 there was excessive heat, and in no one of these 9 rooms was there any attempt to regulate the temperature; in 7 rooms there were no thermometers.

The investigation showed conclusively that scarcely any effort is made on the part of most manufacturers to ascertain the definite conditions with respect to heat and moisture favorable to weaving, by the use of accurate thermometers and hygrometers. The raising of humidity is done in a very unworkmanlike manner. In 23 of the 80 rooms there were no hygrometers; in 2 rooms where hygrometers were present they were broken; and in a large number of rooms one or more hygrometers were found to be unserviceable. In the great majority of instances where hygrometers were used the instruments were untrustworthy. The ordinary stationary wet and dry bulb thermometer for determining the atmospheric humidity is, according to an authoritative writer on this subject, "far from satisfactory for mill use, and except in very careful hands is absolutely worthless." Moreover, most of the men who have the care of the hygrometers either neglect to keep them in order or fail to take accurate records.

Agents or superintendents of a few corporations, on the other hand, have made careful and extensive inquiries in order to determine "what constitutes the best working conditions and what degree of atmospheric humidity for a given temperature will give the best results," on the ground that the information obtained may be, from a commercial point of view, of great importance. These men have used the self-registering hygrometer, or psychrometer, and the "sling hygrometer," with very promising results; and one of them states that, "for quickly and accurately determining the actual moisture and temperature conditions of a room, the sling hygrometer leaves little to be desired for mill use."

That heavy or excessive steaming in mills is injurious to the health of those who work in them has been for years the opinion of competent physicians. On this subject a report of great value was made in 1897 by a committee appointed by the English government. It was this report which made in many respects a new departure in factory legislation. While the amount of moisture allowed in rooms where artificial moisture was introduced had been under government control since 1889, the order of 1898 contained important provisions with regard to the character of the steam introduced into the rooms, in addition to the provisions for the regulation of temperature and the exceedingly valuable provision for ventilation.

### *Conditions of Toilet and Wash Rooms, with Reference to Location, Ventilation and Privacy.*

In the majority of mills the toilet rooms and facilities for washing are beyond criticism, being properly constructed and placed and provided with means for adequate ventilation; and due consideration is given to decent separation of the quarters provided for each sex. In not a few, on the other hand, there is imperative need of improvement as regards structure, location, ventilation and common decency. In a number of instances these conveniences are situated in corners of workrooms, and have absolutely no means of ventilation excepting into the workrooms, the air of which in the immediate vicinity of the closets is noticeably foul, the degree of pollution depending upon general conditions as to cleanliness and care. In a number of mills the closets for the two sexes were found to be separated only by partitions, in which, whether of wood or brick, were many holes of various sizes, some plugged with paper and others not. In one of the largest establishments, some of the women's closets, unprotected by doors, were found to be so placed with reference to the corridor traversed by both sexes that their chance occupants were plainly observable.

### *Conditions as to Means of Egress in Case of Fire.*

Generally speaking, the means of egress in case of fire have been found to be adequate, and in a number of instances most admirable; but in certain cases the possibility of great loss of life in the event of fire is so self-evident as to demand special mention, as follows: —

*A.* A four-storied brick building, 200 by 80 feet. No outside fire escapes on three sides.

*B.* Two sixth-story rooms, with no outside fire escapes. Working in one are 63 persons, including 7 girls under eighteen years, and in the other are 48, including 4 girls under eighteen years.

*C.* Mill with five stories and an attic. From the floor of the attic to the ledges of the windows where the fire escape starts is about 12 feet. An iron ladder is so arranged that it can be lowered to the floor to permit reaching the slanting roof, which is about 90 feet from the ground. From the windows a ladder with rounds which nearly touch the roof leads to the edge of the roof, whence a slanting ladder leads to the ground. In this attic room, about 90 feet from the ground, are 54 employees, mostly women and girls.

*D.* Two large, sixth-floor rooms, with window sills 5 feet from the floor. In one are 23 boys and girls under eighteen, and in the other are 75 employees, more than half of whom are women. A narrow iron ladder leads

from the fire-escape window down the slanting slate roof, the ladder resting on the slates for about 10 feet, and then downward on the side of the building.

*Conditions as to Possibility of Injury through Accidents.*

In a great industry, employing large numbers of persons in a number of different operations which involve the use of various kinds of fast-running, complicated machinery, the theoretical possibilities of physical injury are obviously great; but in practice the actual casualties are relatively small in number and chiefly trivial in character, as will appear on examination of the following analysis of the accident cases which occurred at the second largest establishment in the State, employing 5,200 persons, during a period of almost five years (lacking four weeks). During the whole of this period the actual number of working days was practically 1,500, and the number of accidents was 1,000, or 4 per working week among 5,200 persons, — a proportion which, it may be fairly assumed, compares favorably with that obtaining in the population at large.

*Analysis of 1,000 Accidents which occurred at the Pacific Mills, Lawrence, Mass., during the Period of nearly Five Years, from Aug. 10, 1900, to July 13, 1905.*

The record of 1,000 accident cases reported at the Pacific Mills includes many cases of a trivial nature, as is shown by the fact that 99 cases were not considered serious enough to be sent to the hospital, and 37 persons refused to go, mainly because they thought it unnecessary.

But 1 person was killed outright, and but 1 was fatally injured, during the period of nearly five years.

| | |
|---|---|
| Killed outright, | 1 |
| Fatally injured, | 1 |
| Seriously injured (broken limbs, or amputation necessary), | 86 |
| Slightly injured, | 910 |
| Unclassified (suffered nervous shocks, but physically uninjured), | 2 |
| | 1,000 |

| | |
|---|---|
| Were sent to the hospital for examination or treatment, | 822 |
| Were not sent because injury was thought too slight by overseer, | 99 |
| Refused to go, | 37 |
| Went to family physician by preference, | 41 |
| Killed, | 1 |
| | 1,000 |

| | |
|---|---|
| Spoke or understood the English language, | 794 |
| Did not, or were not fully capable of understanding it, | 206 |
| | 1,000 |

*Actual Causes of Injury.*

| | |
|---|---|
| Caught in machinery in operation in ordinary usage, | 320 |
| Caught in machinery while cleaning contrary to orders, | 111 |
| Careless handling of tools or implements of work, | 98 |
| Handling machinery, merchandise, etc., in transportation, etc., | 137 |
| Slipped on floors, etc., and were caught by machinery, etc., | 61 |
| Injured by trucks or wagons used in the work, | 36 |
| Injured by belts, | 32 |
| Injured by splinters of wood or iron, | 39 |
| Struck by flying shuttles, | 19 |
| Injured while about the elevators, | 19 |
| Falls from stagings or elevated platforms, | 16 |
| Falls from ladders, | 11 |
| Falls down stairs, | 11 |
| Falls through trap-doors, | 6 |
| Falls on ice, or struck by falling ice, | 3 |
| Injured by falling coal, while handling same, or working in coal pockets, | 15 |
| Injured by falling shafting, | 1 |
| Burned by steam or hot water, | 16 |
| Burned by acids or dyestuffs, | 8 |
| Cut by glass, putting hands through windows, etc., | 10 |
| Injured on railroad work, | 17 |
| Accidents caused by horses, | 7 |
| Injured by trenches caving in, | 2 |
| Struck maliciously by fellow workmen, | 5 |
| Unclassified, | 10 |
| | 1,000 |

*Underlying Cause of Injury.*

| | |
|---|---|
| Careless manipulation, | 539 |
| Deliberate carelessness (taking chances of being injured, such as cleaning machinery while running, etc.), | 164 |
| Inattention to surroundings, | 177 |
| Carelessness of fellow workman, | 51 |
| Unforeseen liability, | 60 |
| Unclassified, | 9 |
| | 1,000 |

*Classification of Injured Employees.*

| | | |
|---|---|---|
| Male, | | 804 |
| Female, | | 196 |
| | | 1,000 |

*Classification by Ages.*

| | | |
|---|---|---|
| Under sixteen years of age, | 79 | |
| Sixteen to twenty-one, | 246 | |
| | | 325 |
| Twenty-one to thirty, | | 302 |
| Thirty to forty, | | 176 |
| Forty to fifty, | | 100 |
| Fifty to sixty, | | 64 |
| Over sixty, | | 27 |
| Unknown, | | 6 |
| | | 1,000 |

*Classification by Nationality.*

| | |
|---|---|
| American birth, | 212 |
| Canadian, | 271 |
| English and Scotch, | 182 |
| Irish, | 138 |
| Syrians, Armenians, etc., | 55 |
| Russians, Poles, etc., | 52 |
| German and Scandinavian, | 41 |
| Italian, etc., | 31 |
| Portuguese, | 18 |
| | 1,000 |

*Length of Employment.*

| | | |
|---|---|---|
| Under one month, | 143 | |
| One to six months, | 275 | |
| Under one year, | 124 | |
| | | 542 |
| One to five years, | | 255 |
| More than five years, | | 197 |
| Not stated, | | 6 |
| | | 1,000 |

*Place of Employment.*

| DEPARTMENT. | About Machines. | Not about Machines. | Total. | Hands employed. | Per Cent. injured. Total. | Per Cent. injured. Per Year. |
|---|---|---|---|---|---|---|
| *Cotton Mills.* | | | | | | |
| Carding and roving, general, | 10 | 3 | 13 | 74 | 17.57 | 3.52 |
| Picker rooms, | 23 | 2 | 25 | 22 | 113.63 | 22.73 |
| Card strippers, | 21 | - | 21 | 37 | 56.75 | 11.35 |
| Frame tenders, | 39 | - | 39 | 158 | 24.68 | 4.94 |
| | 93 | 5 | 98 | 291 | 33.68 | 6.74 |
| Weaving, weavers, | 45 | - | 45 | 431 | 10.44 | 2.09 |
| Weaving, loom fixers, | 3 | - | 3 | 48 | 6.25 | 1.25 |
| Weaving, loom cleaners, | 7 | - | 7 | 23 | 30.44 | 6.09 |
| Weaving, general, | 2 | 2 | 4 | 64 | 6.25 | 1.25 |
| | 57 | 2 | 59 | 566 | 10.42 | 2.08 |
| Ring spinning, | 14 | 2 | 16 | 295 | 5.42 | 1.08 |
| Mule spinning, | 15 | 2 | 17 | 55 | 30.91 | 6.18 |
| Spooling and warping, | 3 | - | 3 | 80 | 3.75 | .75 |
| Dressing and web drawing, | 13 | - | 13 | 234 | 5.55 | 1.11 |
| | 195 | 11 | 206 | 1,521 | 13.54 | 2.71 |
| *Worsted Mills.* | | | | | | |
| Sorting, combing and drawing, | 96 | 10 | 106 | 399 | 26.50 | 5.30 |
| Cap spinning, | 48 | 12 | 60 | 304 | 19.74 | 3.95 |
| Mule spinning, | 7 | 1 | 8 | 51 | 15.69 | 3.14 |
| Weaving, weavers, | 80 | - | 80 | 794 | 10.07 | 2.01 |
| Weaving, loom fixers, | 17 | - | 17 | 45 | 37.78 | 7.56 |
| Weaving, general, | 15 | 16 | 31 | 98 | 31.63 | 6.33 |
| | 263 | 39 | 302 | 1,691 | 17.86 | 3.57 |
| Worsted dyeing and finishing, | 49 | 15 | 64 | 595 | 10.76 | 2.15 |
| *Print Works.* | | | | | | |
| Shearing and singeing, | 4 | 1 | 5 | 32 | 15.63 | 3.13 |
| Bleaching, scouring, etc., | 13 | 3 | 16 | 69 | 23.19 | 4.64 |
| Drying or white rooms, | 8 | 1 | 9 | 77 | 11.69 | 2.34 |
| Engraving, | 7 | 2 | 9 | 101 | 8.91 | 1.78 |
| Printing, | 28 | 6 | 34 | 119 | 28.57 | 5.71 |
| Color shop, | - | 1 | 1 | 39 | 2.56 | .51 |
| Steaming and ageing, | 10 | - | 10 | 67 | 14.93 | 2.99 |
| Dyeing and washing, | 6 | 4 | 10 | 107 | 9.35 | 1.87 |
| Finishing, | 9 | 4 | 13 | 109 | 11.92 | 2.38 |
| Folding, | 8 | 4 | 12 | 164 | 7.32 | 1.46 |
| Packing and shipping, | 2 | 10 | 12 | 117 | 10.26 | 2.05 |
| | 95 | 36 | 131 | 1,001 | 13.10 | 2.62 |
| *Repair Shops.* | | | | | | |
| About machines, | 42 | - | 42 | - | - | - |
| Handling tools, | 38 | - | 38 | - | - | - |
| Stagings and ladders, | - | 25 | 25 | - | - | - |
| Others, | - | 20 | 20 | - | - | - |
| About engines, | 6 | - | 6 | - | - | - |
| About boilers, | - | 11 | 11 | - | - | - |
| | 86 | 56 | 142 | 250 | 56.80 | 11.36 |
| Yard and stable, | - | 149 | 149 | 111 | 134.23 | 26.85 |
| Watch, | - | 6 | 6 | 22 | 27.27 | 5.45 |
| | 688 | 312 | 1,000 | 5,205 | 19.21 | 3.84 |

*Examples of Various Types of Mills with moderately or distinctly Bad Conditions, Susceptible of Improvement with Reasonable Expenditure.*

*A.* Small woolen mill. Walls and ceilings dark and dirty. Basement conditions unsatisfactory. Poor ventilation. Means of removing steam inadequate.

*B.* Small woolen mill. Walls and ceilings need whitening. Small windows and poor light in low-studded weave and spinning rooms. (To illustrate a simple means of improving light at trivial expense.)

*C.* Cotton mill, employing 800 persons. Four weave rooms and two spinning rooms are dark, on account of very dirty windows and dingy walls and ceilings. Walls and floor of a mule-spinning room are exceedingly filthy. Ventilation inadequate in the spinning room, and very poor in the weave rooms; in the carding room there are no mechanical means of ventilation and removal of dust.

*D.* Cotton mill, 800 employees; 145 employees under twenty-one years of age. Age of buildings, thirteen to thirty-four years. Weave rooms, walls and ceilings need whitening to improve the light. Ring and mule spinning rooms, ceilings and walls need whitening. Carding rooms, ceilings and walls need painting or whitewashing. Stairways, walls and windows are dirty and neglected; no system of scrubbing or cleaning; floors very dirty. Very poorly ventilated; no mechanical ventilation in the carding rooms, which are filled with dust.

*E.* Mill with 350 employees, mostly American born; largest number are girls and women. The processes of spool winding, bobbin winding and knitting of linen thread are followed in a third-floor room, 164 by 71 feet, in an old building. The ceiling is 11 or 12 feet high. About 70 girls and women are in this room, which is poorly lighted and very unattractive. Some time in the past the lower window sashes were said to have been "painted;" to-day the glass presents a worn, dirty, muddy appearance, and keeps out light, which the room needs. (Glass was said to have been painted in order to prevent the employees from looking out of the windows.) More girls in this room wear glasses than in any other room; more look pale and unhealthy than in the other rooms. The walls and ceilings need thorough cleansing and whitening. The slackness, dirt and bad light are unpardonable, and there should be some efficient means of ventilation in a room with so many occupants constantly at work. The room below needs improvement along the same lines. This establishment well illustrates a type of factories which shows like neglected conditions in one or more rooms, — conditions which can be decidedly improved at an entirely reasonable expense with very little difficulty; and there can be no doubt that such simple changes would affect materially the health of the employees.

*F.* Cotton mill, with 1,400 employees. Weave rooms, mule-spinning rooms and ring-spinning rooms, very dirty walls and ceilings. Poor or bad

light in four rooms; low ceilings in four rooms. New treasurer says plans have been made to reorganize the whole set of mills, and declares that the present system by which the work is done, as well as the condition of the workrooms, is wrong; and that clean workrooms, well painted, with new machinery and proper arrangement of departments, are necessary.

*G.* Coarse-goods mill, employing 3,000 persons. Age of buildings, ten to seventy-five years. Three weave rooms and four mule and ring spinning rooms, low ceilings, poor light, walls and ceilings dirty. Several carding rooms, walls and ceilings very unclean; one room greatly neglected. Picker room dirty, dark and very dusty. Many of the windows very dirty. Many floors old and oil-soaked; some of the weave room floors nasty in places, showing accumulated dirt and water condensed from steam vapor pot system. Stairways need cleaning and whitening. Men, women and children in this mill are exposed to vitiated air, in addition to insufficient light and lack of proper cleanliness.

*H.* Woolen mill, very old. Weave rooms low studded; lighted by gas; dirty walls and dark ceiling. Mule spinning rooms low studded; lighted by gas; light would be improved by whitening walls and ceiling and cleaning very dirty windows. Warping and spooling room low studded; lighted by gas; walls and ceiling need cleaning and whitening. Carding rooms, walls, window sills and ceilings badly neglected. Stairways dirty and neglected; neglected conditions in most of the rooms. Dirty, even nasty, walls, ceilings, stairways and hallways,—apparently neglected for years, as much of the dirt is in layers, and in corners is in "bunches."

*I.* A coarse-goods mill, 150 to 500 employees. Buildings erected 1845–90. Three weave rooms, dingy appearance because of lack of whitening ceilings and walls. One room, 11-foot ceiling, is very dirty and dusty, made nasty by the steam from vapor pots. General lack of cleanliness. Small windows. Basement weave room, 8 feet from floor to timbers; ceiling and walls need whitening.

*J.* Medium-goods cotton mill, employing 200 persons. Original mill built in 1814. Two weave rooms, each 36 by 171 feet, 8 feet high; small windows; ceiling needs to be whitened to improve light; kerosene (glass) lamps hang between looms, suspended by wires from ceilings. Mule spinning room, ceiling less than 8 feet high; ceiling and walls need cleaning and whitening; kerosene lamps; kerosene lamps on movable stands near drawing-in frames.

### *Examples of Mills operated under Commendable Conditions.*

*A.* Mills, erected 1849–92, where colored goods are manufactured. Number of employees, 1,000. Grade of stock, medium to coarse. General order and neatness, good. In a carding room one "sweeper" and one "scrubber" are kept at work all the time; in a weaving room, two "scrubbers;" in a spinning room, one "scrubber," etc. These persons scrub and keep clean the broad alleys and the spare floor; *i.e.*, where there is no machinery. The floors appear to have continuous and thorough scrubbing. The alleys next

to the walls and windows, which in old mills are found commonly to be dirty, are clean. The window sills, also, are kept clean. The water-closets, sink rooms and clothes rooms are orderly and clean. Nearly all the windows are clean; they are said to be cleaned twice a year. The stairways are clean; many women are seen at work scrubbing floors and stairways. Some signs are posted: "Please do not spit tobacco juice on floor or in corners."

*B.* Cotton mill. Number of employees, 1,200. Grade of stock, fine. General order and neatness, good. Considerable care is taken to keep the rooms clean and in order. All of the rooms in the mills compare favorably with those of modern fine-goods mills, so far as general order and neatness is concerned. Sweepers and scrubbers are kept busy all the time. Weavers do not have to sweep around their own looms. Windows are clean; they are said to be cleaned two or three times a year. The whitened ceilings and walls greatly improve the light in the rooms, besides making the rooms attractive, rather than barn-like in appearance.

*C.* Modern mill, two years old, for manufacturing combed hosiery yarns. Number of employees, 500. Grade of stock, fine. Height of buildings, three stories and basement. All rooms are 16 feet high, except the basement, which is 12 feet. The walls and ceilings are clean and smooth. The windows are 12 by 7 feet, with transoms. The size of the window glass is 12 by 16 inches. The upper story has monitor windows. Between the carding machines and the combing department is a glass partition. Arc lights are in the picker, carding, roving and mule rooms; incandescent lights in the combing department. Modern humidifiers are installed for regulating moisture in the workrooms. There are separate water-closet towers, including sink rooms, for men and for women.

*D.* Fine-goods mills, erected in 1871, 1882, 1889 and 1892, in which the conditions from a sanitary point of view are very good. Number of employees, 1,000.

No. 1 Mill, 1871: Top room (spinning), 315 by 87 feet, 15 feet high; equipped with gas. Spinning room, 315 by 87 feet, 13 feet high; equipped with electricity. Upper card room, 314 by 86 feet, 13 feet 8 inches high. Lower card and weave room, 313 by 85 feet, 13 feet 8 inches high.

No. 2 Mill, 1882: Carding and spinning rooms, about 380 by 87 feet, 13 to 14 feet 8 inches high.

No. 3 Mill, 1889: Two weave rooms, about 285 by 96 feet, 15 feet high.

No. 4 Mill, 1892: Two weave rooms, about 400 by 120 feet, 16 feet high.

Nearly all the rooms are light and white (rooms well painted; walls whitened). Sturtevant system of heating and ventilating. Regenerated cold-air system introduced, with vapor steam system. Self-registering hygrometer in use. Some windows have transoms which open; others are so arranged that the top part of the lower sash can be tipped back into the room, — the sides being closed in with wood, — so that fresh air may be admitted into the upper part of the workrooms.

## Manufacture of Carpet Yarn, Twine, Cordage and Gunny Cloth from Jute and Hemp.

The raw material in various forms comes in bales, which are opened and shaken apart, and the contents are then treated according to their nature. Ordinary jute and hemp, after being shaken out, are run through softening machines, in which they are moistened with an emulsion of oil and water, preparatory to carding. Old rope, gunny bagging and twine are run through machines which pick the fibers apart as a preliminary to other processes. Opening, picking, softening and carding are processes which are exceedingly dusty, and the dust is very irritating to the air passages. The machines which straighten and twist the fibers also give rise to much dust.

Three mills devoted to this industry were visited, the largest of which gives employment to about 2,300 persons, including 116 children between fourteen and sixteen years of age, nearly all of whom are girls; and the second in size employs from 200 to 500 persons, according to the conditions of business. In the former the rooms are fairly or well lighted; but all of them, in spite of mechanical ventilation and open windows, are exceedingly dusty, and many of the operatives wear thick bunches of fiber over mouth and nose as a protection. A fairly large proportion of the operatives show the effects of their employment, looking pale and sickly.

In the establishment second in size the light is good, and the ventilation, apart from dust, is fair. The spinning rooms are clean, light and well ventilated. The room in which old rope is picked apart is very dusty, but it is of good size, and is occupied by but 2 persons. The room in which Sisal hemp is fed into breakers has an area of nearly 17,000 square feet for 40 occupants, but the air is filled with dust.

In the third place the rooms are light and well ventilated. In some parts the air contains considerable dust, but the employees in all departments look well and strong.

## Manufacture of Carpets and Rugs.

The processes followed in the weaving of carpets and rugs are very similar to, if not identical with, those of the cotton and woolen cloth industries, but there are certain conditions which are different. In the matter of material, for example, there is a wider range, since yarns of hemp, jute, worsted and cotton are employed. Some of these are bought in bale form, and others are made on the premises. Thus cotton comes in rolls, and is carded, twisted and spun into roving; and wool comes in various forms, and requires different methods of handling. In the sort-

ing of wool the material is handled on benches with perforated tops, through which dust and dirt fall to a box beneath. Some of the wool is "picked" by machinery, back of which are small compartments into which the finely picked fibers are blown. The air in the vicinity becomes heavily impregnated with dust and flying fibers.

Such of the wool as may require it is fed into washing machines, which wash it with soap and water, and then into a series of tanks of water. Finally it is passed to drying machines, in which it is dried by heat.

The yarns that come in baled form are opened up and dusted by machinery, which process causes considerable dust.

Carpet yarns are wound on bobbins and on spindles, and this process is commonly a dusty one. They may be sized with a mixture of glue and paste, to impart stiffness; and some of them are passed through a dressing of paste, with or without color, and then are quickly dried and wound on drums or beams.

The operation of carpet weaving is accompanied by much dust, and requires constant attention and keen watching for flaws and "skips" in the weaving. After a carpet or rug is woven, it is inspected, sheared and brushed. The shearing machines cut off all bits of fiber and other irregularities, and in so doing create considerable dust, much of which is coarse and heavy, and does not long remain suspended in the air.

Five carpet factories visited employ about 6,000 persons, about 10 per cent. of whom are between the ages of fourteen and sixteen. The largest of these shows some departments in which poor light, excessive heat, moisture and dust constitute the objectionable conditions. One large, fairly well-lighted room, 220 by 120 by 16 feet, and occupied by 33 persons, has so much fine cotton dust and fiber in the air that it is with difficulty one can see across it. This dust is very irritating to the nose and throat.

Some of the rooms are poorly lighted, some are overheated and some are badly ventilated; and one large basement room, 285 by 60 by 13 feet, occupied by 150 women and girls winding yarns on bobbins, combines all three of these objectionable conditions.

The wool-picking room is well lighted, but the air is heavy with wool fiber, and is at the same time excessively hot.

One large dusting machine is equipped with a fan and exhaust dust pipe which never have been used; indeed, there is no shafting to run the fan. The machine has been in use upwards of five years, and the person who operates it has worn a handkerchief over nose and mouth ever since it was started. The work is exceedingly dusty and dirty.

The weaving rooms of the next largest of the 5 factories are large and well lighted, but the air contains a noticeable amount of dust. Most of the departments of this mill show commendable conditions.

In the third many of the children between fourteen and sixteen are very small and poorly developed for their age, and are far too poorly developed to be allowed to work ten hours and twenty minutes for five days in the week.

In many rooms the windows are too far apart, and the light is barely sufficient, even in clear weather. The older weavers complain of failing eyesight, due to working with poor light.

One of the mills of this establishment, although comparatively new, is poorly lighted in the picking, carding, winding, drawing and roving rooms, but otherwise the conditions are good. In four of the weave rooms the ventilation is very inadequate, the light is poor and the air is very dusty.

The fourth establishment in order is, in the main, poorly lighted and inadequately ventilated, and the weave rooms are very dusty. In four rooms in which yarns are dressed the steam boxes are so loosely constructed that much steam escapes, and causes extreme heat and moisture. About one-tenth of the employees in this establishment look sickly.

The smallest factory of all, one which employs ordinarily 500 persons, has good light, adequate ventilation and commendable weave rooms. The employees appear to be in good health.

## Manufacture of Shoddy.

Shoddy is made from woolen rags, which come ordinarily to the mill in the form of bales. The first process, after the bales are opened, is that of sorting, which is done by women, who pick out all cotton rags, silk mixtures, buttons and other foreign matters. The selected rags are treated in a large vat with dilute sulphuric acid, which attacks and destroys all cotton fibers which may be present, and then they are removed from the bath and allowed to drain. Next they are spread on racks over steam pipes, and dried at a temperature of about 100° F. in a confined space, which, before the dried rags are removed each day, is thoroughly ventilated by opening the windows and operating a blower, so that the men who do the work may not be exposed to the fumes. The rags are next washed, and then are picked apart by machinery. The product is a pure wool of short fiber and very clean, which is sold either dyed or undyed.

Two establishments of this class were examined, one of which is poorly lighted, inadequately ventilated, dusty and ill-kept; the other is light, clean and well ventilated. Some of the women employed appeared to be in poor physical condition.

### Manufacture of Felt Cloth from Cotton and Wool.

In the manufacture of felt cloth from cotton and wool processes vary somewhat in different mills, but the chief ones are essentially the same. In the picker room different kinds of wool and wool waste, mixed or not with some cotton waste, are put through a "mixer" and a "burr picker." In this department much dust arises, especially when cotton waste is used to a considerable extent.

The material is brought into the carding room in the form of "laps." The carding room is very dusty, but heavy wool stock gives rise to less dust than cotton and wool together. The loose cloth stock is pressed together in order to make a thick, compact sheet. This process is called hardening and fulling. Then it goes through large wooden rolls to be washed, and to the hydro extractor. In the dyehouse the colors used are chiefly anilins, which are dissolved in large wooden vats in hot water. The cloth is introduced and made to run over drums until colored. From the dyehouse the cloth goes to the drier. In the finishing room the goods are pressed, rolled and baled.

Six establishments of this class were examined, and in all of them the work was found to be conducted in fairly lighted, and, apart from dust, adequately ventilated buildings. In each there was more or less dust, especially in the picking and carding rooms; but the amount was much diminished in most of them by means of blower fans.

### Cigar and Cigarette Making.

In the preparation of tobacco leaves for the manufacture of cigars they are moistened with water, then allowed to dry again to the stage desired, and then are spread out by women, who "strip" the stems away; they are next dried again to the desired extent, and are then ready for use. Tobacco must be kept at a certain degree of dampness, in order that it may lend itself properly to the necessary manipulation; and it is kept in covered cans, to prevent excessive drying.

When the cigar is rolled, and the wrapper is applied and fastened with gum tragacanth paste, it is cut at the outer end to the required length, and is then ready for the drying room. In the drying room the cigars are dried, sorted according to color, boxed and labelled.

In the manufacture of cigarettes the baled tobacco leaves are first separated from one another, and the different kinds are then mixed on the floor in a long, low pile, and swept together with a broom. From time to time, as more tobacco is added, the pile is sprayed with water. After standing several hours to "blend" the material is taken to the

cutting machine. After being cut, it is shaken up on a broad bench to make it "stringy." In this process more or less tobacco dust is caused to fly about. The tobacco is then conveyed to the making room in zinc-lined boxes. Here it is rolled up in a bit of parchment paper, which, with its contents, is slipped into a paper tube, and then the parchment is withdrawn. The loose ends are then trimmed, and the cigarette is ready for the drying room, where it is kept several days, in order to be brought to the required degree of dryness (or moisture). The paper tubes are stuck together with starch paste, to which a little wheaten flour is added.

The number of cigar and cigarette factories visited is as follows: cigars, 134; cigarettes, 11. These are situated in Acton (1), Boston (80), Cambridge (3), Chelsea (10), Everett (1), Fall River (1), Fitchburg (5), Hyde Park (2), Lawrence (8), Lowell (4), Lynn (4), Malden (1), New Bedford (2), Newburyport (1), Somerville (4), Southbridge (1), Springfield (1), Waltham (3), Westfield (9) and Worcester (6); and they include establishments of all sizes, from those employing less than 5 persons to those with many hundreds.

As regards light, ventilation and general sanitation, the reports of 127 establishments are from "fair" to "good," and in 18 the general conditions observed were moderately or distinctly bad. But in this industry, as a whole, certain highly objectionable practices prevail very extensively. The spitting habit, for example, is especially common; and, apart from the danger to which the health of the employees is thereby exposed, is particularly to be deprecated, in view of the fact that in the processes of manufacture considerable tobacco falls to the floor, and these fragments, if not gathered up and used on the premises, are very commonly swept up with all the dirt, dried sputum and other matter, and sold as fillings for cheap cigars.

A still more objectionable practice is that of finishing cigars with the aid of saliva. This was observed in more than one-third of the places visited. Attention was called to this habit in the report on industrial conditions, made to the Legislature in January, 1905, which contained the following statement: —

> The possibility of disseminating loathsome diseases through this practice needs no extended discussion. Perhaps it would be fair to say that it is uncertain how long the germs of certain diseases which might appear to be transmissible in this manner may retain their vitality in contact with moist tobacco, but the idea is sufficiently revolting on æsthetic grounds alone.

In 18 factories the practice of biting off the end of the filler and inner wrapper with the teeth was also observed.

In a number of factories there was much overcrowding, some were very dusty, some very dirty in every part, and some extremely hot and foul smelling. A fairly large proportion of the employees looked pale and sickly, and in some of the largest establishments this proportion was noted as about one-tenth.

In about one-tenth of the factories the water-closets were noted as being "unclean," "offensive" or "filthy."

### Chair Manufacturing.

The largest of the 9 chair factories visited employs 1,451 persons, the smallest employs but 8; the total number of employees in the 9 establishments is about 2,600.

The woodworking machines employed are run at high speed, and in general are well guarded. They create much dust and large amounts of shavings and chips, but many of them are equipped with exhaust fans and dust flues which lead to the furnaces. The dust which escapes into the air is not especially fine, and, while it settles to a considerable extent upon the operatives, it appears to cause no great discomfort.

In the manufacture of chairs from rattan the material is bleached with sulphur fumes and treated with quicklime and chlorine; but those engaged in the several processes assert that, although the work is somewhat disagreeable, they are conscious of no impairment of health therefrom. The dust arising from the shaving machines, which are fed largely by young women, causes very little irritation and no complaint.

In all of the establishments visited (situated in Gardner and Wakefield) the conditions as to light and ventilation were found to be fair or good; the toilet arrangements were, with one exception, fairly commendable; and the employees showed, as a rule, a healthy appearance. In but one did the spitting habit show itself to a considerable extent, and in one were posted notices prohibiting the practice, under penalty of a fine of $5.

In the largest of the establishments, in which 1,451 persons were employed, but in which the number sometimes reaches 1,700, the largest number of accidents in any one of the years 1899–1905, inclusive, due to the fast-running machinery, was 34; in one year (1901) the number was but 7. The accidents are due to flying pieces of imperfect wood, and to inattention due to the monotony of feeding the machines.

### Whip Making.

In the manufacture of whips various materials are used, including heavy rawhide, East India buffalo hide, rattan, wood, glue, cotton thread, paper, anilin dyes, varnish and others. The machines employed

in splitting rattan, turning and tapering rattan and wood, give off considerable dust in spite of their equipment with blowers and dust flues; but the workmen assert that the dust is not especially irritating or troublesome. The machines which plait and those which wind the whips with paper and thread create no dust.

Eight of the 9 factories visited were noted as being fairly well lighted and ventilated, and equipped with hoods and blowers; and in all the appearance of the employees as to health was good. In the largest, which employs 200 men and 65 women, there was much spitting on floors and stairways; in 4, the habit appeared to prevail to some extent, especially in 1 employing about 150 persons, about one-third of whom are women; in the others no spitting was observed.

### Manufacture of Mouldings and Frames.

In the manufacture of mouldings and frames all the several processes are accompanied by much dust, or by the fumes of wood alcohol. If the woodworking machinery is well protected and provided with hoods, by far the greatest part of the shavings and dust is taken away.

Bronzing is also a dusty process, and those who engage in it uniformly refuse the use of respirators. In the 4 moulding establishments visited the woodworking machinery was found to be well equipped with exhaust ventilation, which conveyed the dust and shavings to the boilers. In 3, where the operation of bronzing is carried on, there was considerable bronze dust. In 1 the fumes of wood alcohol were very strong, in 1 moderately strong, and in a third only perceptible.

In the largest of these establishments 60 persons are employed; in the smallest one, 2. In the latter there was very little business, and correspondingly little machinery.

### The Boot and Shoe Industry.

Second only to the textile industry, as a whole, but of greater commercial importance than either of the chief divisions of the same (cotton and woolen manufacture) alone, stands the boot and shoe industry. According to the census of 1900, while the value of the textile production of Massachusetts was $213,000,000, including $110,000,000 for cotton and $73,500,000 for woolen goods, that of the product of her boot and shoe factories was no less than $117,000,000. As in the case of textiles, so with boots and shoes, Massachusetts leads all other States, — indeed, she manufactures nearly half the shoes produced in the whole country, — Massachusetts, $117,000,000; all other States combined, $135,000,000. The nearest competitor, New York, produces but little more than one-fifth as much as does Massachusetts.

In this enormous industry many thousands of persons are employed in a large number of factories in many cities and towns in all parts of the State; in 3 cities it is the leading industry, and also in a number of towns. In the course of this investigation 373 factories, situated in the following cities and towns, were visited: —

*Cities.*

| Place. | Number of Factories. | Place. | Number of Factories. |
|---|---|---|---|
| Beverly, | 12 | Lynn, | 120 |
| Boston, | 1 | Marlborough, | 7 |
| Brockton, | 43 | New Bedford, | 1 |
| Chelsea, | 8 | Newburyport, | 8 |
| Everett, | 2 | North Adams, | 3 |
| Fitchburg, | 2 | Peabody, | 1 |
| Haverhill, | 65 | Pittsfield, | 2 |
| Lawrence, | 1 | Salem, | 8 |
| Lowell, | 6 | Worcester, | 7 |

*Towns.*

| Place. | Number of Factories. | Place. | Number of Factories. |
|---|---|---|---|
| Abington, | 3 | Natick, | 9 |
| Athol, | 1 | Randolph, | 3 |
| Braintree, | 3 | Reading, | 1 |
| Conway, | 1 | Rockland, | 5 |
| Dalton, | 1 | Spencer, | 2 |
| Danvers, | 3 | Stoneham, | 2 |
| Framingham, | 1 | Stoughton, | 3 |
| Georgetown, | 4 | Wakefield, | 1 |
| Holbrook, | 1 | Wayland, | 2 |
| Hudson, | 4 | Webster, | 2 |
| Marblehead, | 13 | Weymouth, | 4 |
| Middleborough, | 3 | Whitman, | 2 |
| Milford, | 2 | | |

The factories visited include many of small size, as well as the largest and most modern establishments in the State. The investigation shows that even in the smaller and older establishments as much care can be and is given to the health and comfort of the employees as in the very best of the largest.

The processes involved in the manufacture of boots and shoes are numerous and exacting, and some of them are accompanied by condi-

tions which, unless care be taken to prevent their full influence, may cause injury to the health of the operatives. For a proper understanding of the hygiene of the industry the following description of the work of the various departments is presented: —

*Cutting Department.*

In the manufacture of shoes the first process is that done by the "cutters," who cut the leather, on a specially prepared board, with sharp knives, and inspect it carefully to detect imperfections, which work calls for good light.

In certain kinds of shoes the material which is to form the "upper" is taken to the crimping machine, which stretches and curves the leather so as to make it more like the "last" in shape, and later it is cut again.

This work is carried on generally in a large room in conjunction with a number of related processes, which, according to their nature, call for the services of men or boys, women or girls. The cutters are men, as are also the lining cutters, who are comparatively few in number, one being able to cut linings for many cutters. The size and case number are stamped on the linings by women or young men, who may sit while at work.

The reënforcement of parts with cotton cloth is done by machines attended by boys or girls, who may stand or sit, as they like.

The remnant pieces from the operation of cutting are saved for "tongues" and "eyelet stays," which are cut by boys and young men with dies and mallet. Trimmings for sock linings are cut from sheepskins or split sheepskins, known as "skivers," by men, who stand at their work.

The "tips" are perforated by machines operated by young men, who may sit or stand, at will. The edges of the leather are blackened by boys or young men with a mixture of naphtha and lampblack, only a small quantity of which is kept in the building, the main supply being kept elsewhere.

Before going to the stitching department the "outsides," linings and trimmings are "booked."

*Stitching Department.*

In the stitching department, as in the cutting department, men, women, boys and girls are employed. Before the parts of the shoe are put together the lining is joined together by a stitching machine, and is then trimmed and stitched to the "outside" by means of the "closing-on" machine, both of which machines are operated by women. Processes vary according to the kind of shoe.

The edges of the vamps, quarters, tips, etc., are covered with a cement

made of rubber and naphtha, which is kept in small bowls on the benches in front of the employees (women and girls), who naturally are exposed to the fumes of naphtha arising therefrom. Several grades of cement are used; the cheaper grades, which give off the more disagreeable fumes, answer all of the requirements of the stitching department, but for sole-laying and cementing channels they do not give satisfaction. The cemented parts are allowed to dry, and the edges are then turned over by pressing machines, which give a finished appearance.

The shoe is put together by stitching the vamp to the quarters. This is done by both men and women, and is work which demands much care. Several different processes are followed, according to the kind of shoe, the heavier work being done by men. Machines for eyelets are operated generally by men, but those for buttonholes are run by women.

### *Sole-leather and "Stock-fitting" Departments.*

In the sole-leather and stock-fitting departments the stock is "got out" by being cut into shape, channelled, etc. This work is done by men. The resulting soles and the finished uppers now go to the "making" department.

### *Making Department.*

The making department includes several divisions, known as lasting, heeling and finishing, which in turn include many sub-divisions. The employees are men and boys, and the work is mainly "standing" work. Only eight of the processes are of any especial sanitary importance, from the fact that the conditions regarded as essential may affect injuriously the health and comfort of the employees. These are: —

1. Heel trimming or shaving.
2. Edge trimming.
3. Buffing.
4. Naumkeaging.
5. Heel scouring.
6. Breast scouring.
7. Polishing.
8. Cleaning upper.

1. *Heel Trimming or Shaving.* — The heel-trimming machine has two knives, which revolve from 4,000 to 7,000 times per minute; these remove the rough part of the heel. One of the machines is especially adapted to the "heel seat," the knives being so made that they can cut around this portion of the shoe.

The workman must exercise great care to do the work properly, and avoid injury to his fingers. He stands in front of the machine, which is about 4 feet high, and in order to see every portion of the heel he must

bend his head and shoulders forward. Because of the swiftly revolving knives, he grips the shoe tightly with his left hand over the heel and his right over the toe. The work causes circular or oval-shaped callosities of varying thickness on the outer and upper aspect of the last two joints of the left forefinger, and commonly also of the middle finger of the left hand. Gloves made especially for this work are said to interfere with rapid handling and, because of the wear and tear which they suffer, their constant use is considered expensive. The constant standing is favorable to the development of the condition known as "flat foot," which is not uncommon among these workers.

The machine has a pipe and exhaust draft system, designed to draw the dust away from the workman's face, which is commonly brought within 7 or 8 inches of the knives.

This work is "piece work," and the employees average about 600 to 700 pairs per day.

2. *Edge Trimming.* — The machine for trimming the edges of the sole contains a circular knife, composed of a number of cutters, which makes several thousand revolutions per minute. Knives of different shapes are used for different edges.

The workman, who sits at his work, after shaving the sole of one shoe must shave the edge of that of its mate to a corresponding width. This requires good light, accurate eyesight, considerable skill and close attention. The process causes varying amounts of leather dust, the finest of which, in well-equipped factories, is sucked at once into a pipe, attached near the cutters, by a strong exhaust draft, and carried to the dust-room or to the outside of the building.

3 and 4. *Buffing. Naumkeag Buffing.* — In the process of buffing, the sole is brought in contact with a revolving roll, composed of paper, cloth and carborundum, which gives a result similar to that of sandpapering. Very much fine dust is caused, and, unless the machine is equipped with a powerful exhaust-draft dust pipe, the workman's face, especially if he be short of stature, is much exposed thereto. The distance between the face and the revolving roll varies from 5 to 10 inches.

*Naumkeaging or Naumkeag Buffing.* — The Naumkeag machine reaches that part of the shank which the rotary roll of the buffing machine cannot touch, and it scours, brushes and smooths the leather with carborundum for the staining process in the finishing department. The dust which arises in this process is very fine, but is less in amount than that caused by buffing.

5 and 6. *Heel Scouring. Breast Scouring.* — In heel scouring a felt wheel is used, covered with carborundum, moulded paper and cloth. The process gives rise to more or less dust, which, in the main, is carried

down inside the machine by a suction draft. Breast scouring is done with a conical carborundum wheel which gets up under the shank. This machine also is connected with an exhaust blower designed to carry the dust away from the worker's face.

7. *Polishing.* — Polishing is done with revolving bristle brushes and cloth wheels. Blacking is applied to the shoe bottom, wax is put on the brush or wheel, and the bottom of the shoe is held against the brush or wheel, which revolves with great rapidity. More or less fine dust arises, consisting of wax, lint and blacking.

8. *Cleaning Upper.* — The last process in the making department, previous to stamping and pulling off the last, is that of cleaning the upper with the "Webster cleaner" machine. A tank of water connects by means of a large wick with the surface of a rapidly revolving bristle brush, which takes up the water and conveys it to the shoe, which is then wiped with a seersucker brush, the edges of which constantly wear off, causing much lint dust to fly into the air. The men who do this work are usually black from head to foot, and the wall near the brush becomes plastered with black lint.

*Packing Department.*

In the packing department several processes are conducted, among them "treeing." The "Miller treeing machine" has "tree legs" and "tree feet," upon which the shoes are fitted closely for the ironing or "treeing" process, which is done by irons heated by electricity or gas, and operated by men, who stand at their work. Here, also, women sit at benches repairing tips cracked in the process of making. The packing is done by men.

*Conditions observed.*

*Light.* — In the various processes of manufacture good light is essential to good work, and in the great majority of the factories visited the report as to this condition is favorable. In 50 establishments the lighting of certain rooms was found to be barely fair, or poor, and in 26 it was distinctly poor, or even bad.

Good light is especially important with edge-trimming machines, and in most factories these are well placed. With good light the operative does not have to bend so closely over his work, and consequently is not so much exposed to the influence of the dust produced.

A not uncommon arrangement of some machines places them so that they face the light, which in some processes necessitates bending over the work, or raising of the hoods, so as to see well, with consequent increase in the amount of escaping dust.

Of the poorly lighted rooms, the air in 35 was noted as not only foul, but containing much fine dust or lint.

*Ventilation.* — In the majority of the factories visited the ventilation was found to be poor, or distinctly bad; and in most cases where these conditions obtained, there was excessive heat. Where the ventilation is poor, the air becomes much worse toward night; and in some cases it is so bad that the employees assert that they are sometimes nauseated on entering the workrooms in the morning. These are usually long and narrow; and if, in cold weather, the windows are opened, cross-drafts are established. Some foremen say that, while they would be blamed were employees to complain that they had taken cold from open windows, they are not blamed by employees for sickness due to vitiated air and overheating. Crowding of rooms with machinery and stock facilitates work by shortening the distances through which the shoes have to travel in the processes of manufacture; and it is asserted that more cubic space per capita would involve a considerable addition to the general expense of maintenance.

In 103 factories strong odors of naphtha were observed. In some establishments it was said that the odors are so overpowering that the girls who handle the naphtha cement become nauseated, and suffer from headache. Some of the naphtha cements cause much more trouble than others. In 24 factories fumes of wood alcohol were plainly observable.

In a certain number of rooms strong odors of naphtha were noticed, in addition to wood alcohol fumes. In 74 of the many unventilated rooms, some of which were overcrowded and overheated, the employees were exposed to strong fumes of naphtha or of wood alcohol, or of both. As stated elsewhere in this report, wood alcohol fumes are a very real danger to health, and especially to sight, not infrequently causing total blindness; but no instances of trouble arising therefrom were reported in the investigation of this industry.

In one room, occupied by 110 persons, including 10 girls and women, using naphtha cement, the odor of naphtha was very strong; the air was otherwise distinctly foul, and the heat was excessive. In addition, the light was so poor that at 11 A.M. the gas was being burned. In many other rooms occupied by women and minors there was no attempt to ventilate, and the air was overheated and heavy with naphtha fumes. In one all of the 12 girls engaged in the use of cement were noticeably pale.

In some factories a patent can is used, which prevents waste by evaporation, and hence diminishes the fumes of naphtha and wood alcohol. It has a spring top, which is pressed down, and closes when the finger is removed.

Of the rooms in which dust is not an important factor (stitching, cementing and cutting), no fewer than 102 were found to be badly ventilated and 26 to be overcrowded.

*Removal of Dust.* — The rooms in which large amounts of dust are evolved are those in which the operations of heel trimming, edge trimming, buffing, naumkeaging, heel scouring, breast scouring, polishing and upper cleaning are conducted. For effective removal of this dust, exhaust flues attached to the machinery are necessary. Of the 373 factories visited, 126 are partially, and a fair proportion of these are wholly, equipped with this means of protection to the workmen; in 88 of these 126 one or more machines are not so equipped; and in 49 of the 88 there are rooms in which the air, apart from the escaping dust, is noticeably bad.

The number of machines with means for efficient or fairly efficient removal of dust was found to be 1,630; the number either inefficiently equipped or devoid of equipment was reported as 2,769.

The reasons for inefficiency include improper adjustment of hoods, clogging of pipes, leaking pipes, bad connections, poor draft, small openings, small pipes, improper position of machine with reference to light, necessitating the raising of hoods in order to see well. It appears, however, that a machine may be fairly effective in dust removal with one kind of work, and faulty with another; and that, while with some kinds of material a well-equipped machine may give off some dust, with other material a machine without exhaust drafts may create little, if any. Again, in edge trimming much less dust is produced when light and thin-soled shoes are made; and, further, it not infrequently happens that, owing to changes in styles of shoes, it becomes necessary to introduce machines into places where such were not originally intended to go, or processes are modified so that machines which worked unobjectionably before give off much dust when employed on a different kind of material. Thus it happens that in certain factories, in which there is an evident intention to have all conditions perfect, a set of machines may be found whose running is attended by objectionable conditions. It is only fair to state that in one city (Marlborough) nearly all of the factories have unusually good dust-removing machinery, and that the results are generally most commendable.

Of 84 of the many unventilated and dusty rooms reported in the course of this investigation, 40 were overcrowded, 35 were dark, 21 were overheated; and 18 were overcrowded, dark and overheated.

*Water-closets.* — In 135 of the factories visited the conditions as to water-closets were found to be not commendable. In most of this number the closets were dark and dirty to very dirty. In one of the centers of this industry many of the closets are built directly in the middle of the workrooms, and are wholly unlighted; and leaking pipes are not uncommon.

*Health of Employees.* — While in general the employees appear to be in fair to good health, in 85 factories a considerable proportion of them are noticeably pale and unhealthy in appearance.

*The Spitting Habit.* — In all but 50 of the 373 factories examined the habit of spitting was noticed to obtain to a greater or lesser extent. In 35 the report is "much;" in 115 it is "considerable;" in 173 it is "some."

*The Noon Hour.* — In the great majority of factories the time allowed for the mid-day meal and rest is one hour; in 21 it ranges from 65 to 75 minutes; in 40, from 45 to 55 minutes; in 13 it is but a half hour. In a large proportion many employees do not leave the premises, but eat in the workrooms, taking little if any time for change of air. In some, lunch rooms are provided, where the employees may eat the luncheons which they have brought with them, or buy according to their desires and means.

*Employment of Minors.* — In 47 of the 373 factories a considerable number of the employees look to be about fourteen years of age, and in 14 of them the proportion of minors is large. Many of this class are noticeably pale and poorly nourished, and show the effects of the unhygienic influences to which they are subjected. Many appear to be about twelve years of age, but have certificates that they are sixteen. If true, these boys are singularly undeveloped, and, if they are allowed to continue working in factories, will probably become public charges at no late day.

### *General Conditions.*

Owing to the complex set of facts reported, an accurate comparative classification of factories, from an hygienic point of view, cannot be made; but a list of 62 factories was reported on the same basis, as showing absolutely satisfactory hygienic conditions. In 91 the conditions were unsatisfactory; in 72 they were poor; and in 19 they were distinctly bad.

### *Examples of Factories with Moderately or Distinctly Bad Conditions, Susceptible of Improvement at not Unreasonable Expense.*

*A.* About one-tenth of the employees look unhealthy. In two rooms, occupied by 45 and 70 persons, respectively, no attention is given to ventilation, and the air is very bad.

*B.* Room with 40 occupants, overcrowded, overheated, unventilated; much spitting. Room with 30 occupants, overcrowded and unventilated. Room with 70 occupants, overheated, unventilated, and smelling of naphtha.

*C.* In an overheated, somewhat crowded room, 35 girls and women are exposed to strong fumes of naphtha and of wood alcohol. In another room, occupied by 60 persons, there is excessive heat, and no provision for ventilation. Much spitting on floors.

*D.* Among the employees are a number who appear to be under fourteen years of age. Twelve girls are exposed to fumes of naphtha and wood alcohol. Twenty-six men exposed to much dust. Ventilation in general very poor.

*E.* Five rooms, overcrowded, dark, dirty, unventilated and dusty, occupied by 312 persons. Much spitting. Water-closets dark and filthy, causing stench in workrooms.

*F.* Employees include 8 children who are apparently below fourteen years of age. Two rooms, occupied respectively by 50 and 80 persons, overcrowded, unventilated, and one of which is so dark that gas is burned all day. Water-closets dark and dirty.

*G.* From 5 to 10 per cent. of the employees look sickly, most of them polishers, scourers, edge trimmers, and girls in the stitching rooms. Room with 100 occupants, overcrowded, overheated and unventilated. Three rooms with no ventilation; two overcrowded, and one so dark that gaslights are required at 2 P.M. on a bright, sunny day. Water-closets dark and dirty.

*H.* About 10 per cent. of the employees appear to be in poor physical condition. Room with 75 occupants, overcrowded, overheated, unventilated and badly lighted. Room with 50 occupants, dark, dusty, and with foul air. Two rooms with 20 and 12 occupants, respectively, dark and poorly ventilated. Room with 100 occupants, overcrowded, overheated, badly lighted. Water-closets dark and dirty.

*I.* About one-fifth of the employees are below twenty-one years of age, and not a few between fourteen and sixteen years. Room occupied by 130 persons, overcrowded and badly ventilated. Twelve scouring and buffing machines facing the light have covers removed, so that the dust escapes into the room and flies into the faces of the operatives. Room occupied by 159 persons, chiefly women and girls, overheated and unventilated. Much spitting on floors.

*J.* About 10 per cent. of the employees in the stitching and making rooms look unhealthy. Room with 110 occupants, dark, gaslights burning at 11 A.M., crowded, overheated, unventilated, with strong odor of naphtha. Room with 50 occupants, 6 of whom are boys about fourteen years of age, very dusty and badly lighted. Three basement rooms, so badly lighted that gas is required all day, and badly ventilated. Water-closets dark, very dirty and unventilated.

*K.* Fully one-tenth of the employees are noticeably pale and in poor physical condition. Room with 140 occupants, poorly lighted, much overcrowded, overheated, unventilated, and with strong odor of naphtha. Water-closets dark and dirty.

*L.* At least one-half of the employees look pale and in poor condition. Rooms dark, dirty, unventilated. Water-closets dark and dirty.

*M.* About one-tenth of the employees seem to be in poor health. Several weak-looking boys exposed to strong odors of wood alcohol. Room with 60 occupants, crowded with stock, air bad, and strong odor of naphtha in various parts. Room with 75 occupants, overcrowded, overheated, unventilated. Room with 50 occupants, crowded with stock and machinery, air foul and dusty. Nearly all of the water-closets dark and dirty.

*N.* Throughout the building the air is poor. The system of indirect steam heating is in use, and the air is drawn from the workrooms and heated and sent back again constantly. The only intake for fresh air is in the basement, where drainage from the sole-leather department causes disagreeable odors. Water-closets are dark and dirty. About one in ten of the employees appears to be in poor health.

*O.* Room with 50 occupants, several under eighteen years of age, very hot and air very foul. Much spitting on the floor. Some of the machines give off a great deal of fine dust. More than half of the cubic space in this room is taken up by stock and machinery. Room with 130 occupants, so crowded with people, stock and machinery that locomotion is difficult. No ventilation is attempted, and the air is foul. The room is overheated. There is much spitting. Ten girls at work with rubber cement, and the odor of the naphtha adds to the discomfort. In all the rooms of this factory there is excessive heat, and the air is foul. The water-closets are dark and dirty.

*P.* The windows are opened a short time before 7 o'clock A.M., but remain closed for the rest of the day, owing to fear of drafts. The room is crowded and the air is bad, and there is considerable trouble from dirt sifting down through the cracks in the floor above. Two other rooms, with 60 and 65 occupants, respectively, are crowded, overheated, dirty and unventilated, and there is much spitting on the floor. The water-closets are dark and dirty, in spite of an assessment paid to keep them clean. They are in poor repair; there is leakage from upper floors into the closets and sinks on the lower floors.

*Q.* A number of the employees in the stitching department are noticeably pale. In one room in another department, poorly lighted, overheated and unventilated, the exhaust pipes have been removed from six of the polishing machines, and a large amount of dust and dirt is thrown into the air. In different parts of the building are machines provided with exhaust drafts, which do not bring about the desired result. Parts of each floor are crowded, dark and dirty, and there is much spitting. The water-closets are dark and dirty.

*R.* Room occupied by 150 persons, who depend upon one sink, 12 by 24 inches, and one faucet, for drinking and washing facilities. There is a dark, dirty and wet water-closet, 2½ by 5 feet, in centre of the room, with two doors, Another room, occupied by 90 persons, is poorly lighted, overcrowded, overheated and not ventilated. The basement is dark and wet, and the men working there look unhealthy. The factory as a whole is dark and dirty, and the general conditions are bad. In another building a large proportion of the employees are minors, 17 of whom are below sixteen years of age. Room with 195 occupants, and another with 140 occupants, both crowded and unventilated, and one overheated and poorly lighted.

*S.* Room with 120 occupants, exposed to much fine dust; 20 men exposed to strong fumes of naphtha and wood alcohol. Some of them are noticeably pale, but all of them have become accustomed to the smell. Another room, with 120 occupants, overheated and not ventilated. Much spitting on the

floor. Some of the women and about one-half of the minors of both sexes look pale and poorly nourished. Basement room, with 30 men, boys and girls, poorly lighted. The girls are exposed to strong odor of naphtha, and they are noticeably pale. Room with 285 occupants unventilated and overheated, in which a dozen girls are exposed to an unusually strong smell of naphtha; and, though they are noticeably pale, they say they have become used to it. Floors are dirty, and there is much spitting. Some of the rooms are poorly lighted. The water-closets are very dirty, and some are dark.

*T.* An unusually large proportion of boys and girls, many of whom seem to be in poor health. Rooms overheated, dark, and in need of ventilation. Boys exposed to strong naphtha odors. Water-closets dark and dirty.

*U.* Among the employees are 3 boys, apparently about twelve years of age, who are said by the proprietor to be in the employ of the men in one of the rooms. Several rooms are very dirty, overcrowded, overheated and dark. The water-closets are dark and dirty.

*V.* Unusual number of children, apparently fourteen years of age or less; 3 or 4 boys appear to be about twelve; all have certificates, however, stating their age to be sixteen. They are hired and paid by the workmen in various departments. If the statements in the certificates are true, the boys are abnormally small and undeveloped, and ought not to be employed in factories.

*W.* About 15 per cent. of the employees look poorly. The pay roll carries the names of 80 children under sixteen; the total number of minors is about 250. Room with nearly 200 occupants, overcrowded, unventilated; 20 of the occupants are under eighteen, and 6 or 8 appear to be under fourteen. Other rooms, with from 55 to 150 occupants, some of them children apparently under fourteen, overcrowded, badly lighted, poorly ventilated. The general condition of the place as to light and ventilation is poor. Many of the water-closets are small, some dark, and nearly all very dirty.

*X.* A large number of minors, and a large proportion of the employees in poor condition; 66 children said to be between fourteen and sixteen years of age, but fully one-third appear to be less than fourteen. If they are over fourteen, they are so abnormally small, undeveloped and badly nourished that continued employment in a factory would seem to be most undesirable. In two rooms the exhaust pipes attached to the machinery are absolutely inefficient, and the air is foul with dust.

*Y.* Large number of children from fourteen to sixteen, and many of them are in poor condition. Rooms occupied by from 40 to 160 persons, are overcrowded and not ventilated. In some the odor of naphtha is strong; in some the dust is excessive. In one, with 40 occupants, a cloud of fine dust flies from eleven scouring machines and settles upon the walls and wherever it can reach, and men complain of great discomfort therefrom. Half of the men look unhealthy. From nine rotary brushes a great deal of fine black dust and lint is thrown, and it settles everywhere, including the faces and especially about the nostrils of the workmen. All of the men in this room, and 3 boys aged about sixteen, appear to be in especially poor health.

*Z.* Large factory, employing more than 1,000 hands. Room with 360

with cyanide of mercury. The different kinds of fur are mixed together in large covered machines, in which the coarse hair is separated from the soft, downy fur, which latter is taken to the felt machine. This consists of a revolving copper cone, perforated with numerous small holes through which the air is drawn by suction apparatus. The cone is enclosed in a barrel-like covering, open at the top, which has a door in the side for the removal of the felt as made. The fine hairs are blown into the upper part of the enclosure, and they are attracted toward the perforated cone by the air currents going thereto. They are then deposited in a thin layer on the outside of the cone, and when the deposit has gone on to a sufficient extent a cloth wrung out in hot water is applied, and the cone and its covering are removed and plunged into hot water for a short time, the heat and moisture causing the individual hairs to become more intimately matted; then the conical layer is pulled off and sent to the shrinking room.

The newly made felts are rolled into small rolls, and thrown between two rollers which revolve in a trough of hot water. These are deeply grooved in a spiral manner, and are from one and one-half to two inches apart. Because of their spiral construction they alternately squeeze and relax the felt, now squeezing out the water, now permitting the taking up of more. As the water is nearly boiling, the room in which this work is done is naturally hot and damp. The hot water causes the felt to shrink, and in bringing this about the cyanide of mercury with which the fur was originally treated is of assistance.

It is said that some of the men are affected by the mercury compound when they come in contact with it in handling the wet felt. The lesions produced are commonly a few bright red papules, occurring in groups of three or four, or singly, upon the backs of the fingers and hands; these papules itch intensely. Pustules also occur. After a varying length of time, usually short, especially if the lesions are covered with collodion, they disappear, but they may recur. Some men are so susceptible to the effects of the mercury that they are obliged to discontinue their work.

The felts are sometimes shrunk by hand, in which case they are dipped into a trough of boiling water, and the water is wrung out by rolling with a wooden roller. The table at which this work is done slopes away from the workman toward the trough, so that the workman does not necessarily get wet.

The rough felt cone after being shrunk is smoothed off with a machine knife, containing a set of revolving blades which work against a fixed knife, like an ordinary lawn mower. The fluff given off is drawn away by a suction blower pipe, but considerable dust gets into the atmosphere, in spite of all precautions. The cone is then treated with a solution of

shellac in wood alcohol, and the excess is wrung out. Then it is placed in a drying oven, and the alcohol is dried out of the felt, condensed and recovered. In some of the establishments visited, the fumes of wood alcohol in this department were markedly strong; and the workmen stated that they are frequently troubled with headaches, vertigo, smarting and burning of the eyes and impairment of vision, and that few can remain at this work longer than three or four months at a time.

There are several other processes, including hardening, sizing, dyeing, pouncing and finishing, which follow; but none of them has any essentially dangerous characteristic excepting that of "pouncing," which consists in smoothing off the rough hairs from the hat rim and other parts, and gives off a great deal of very fine dust.

Of the 4 felt hat factories visited, the largest employs about 350 persons, in a fairly well-lighted and properly ventilated building. The lower story of the building is far wetter than is necessary or desirable; but it must be said that the persons employed there are largely to blame, partly on account of ignorance, and partly on account of indifference. The water-closets are uncleanly, but this also appears to be the fault of the employees. A large dressing-room is provided, but it is built without regard to ventilation, has few windows, and is offensive to the sense of smell. In each of the sizing rooms there is much steam in the air, in spite of six 6-horse-power exhaust fans. In the finishing department the windows are kept closed, but ventilation is secured by means of two large exhaust fans. In the pouncing room there is considerable dust, in spite of the blowers.

The next largest establishment employs 200 persons, in a well-lighted and thoroughly ventilated building. The shrinking room is necessarily hot and damp, but the 10 occupants are very lightly clad, and before leaving the building they make a complete change in their clothing. In the shellac room the fumes of wood alcohol were noted as strong, in spite of eight open windows and roof ventilation.

In the two smaller remaining establishments the conditions were not materially different from those observed in the larger ones with respect to the wood alcohol and "pouncing" dust. Both establishments are well lighted and adequately ventilated. The employees appear to be healthy. In one of them the rooms were not kept in as neat a condition as could be desired.

### Horn and Celluloid.

In the year 1774, or shortly thereafter, the horn industry had its beginning, in Massachusetts, in the kitchen of the house of Obadiah Hills of Leominster, in which town there are now no fewer than 29 establishments, which give employment to nearly 1,900 persons, in the manufac-

ture of combs and hairpins of horn and celluloid. Three other concerns, 2 in Newburyport and 1 in Northborough, give employment to upwards of 300 more. Until the late 70's the product of the Leominster factories was horn and combs, and then hairpins began to be manufactured as well. The use of celluloid is one of more recent date.

Formerly, every comb maker obtained his supply of horns and "got out" the stock in his factory; but now the stock is bought all pressed, and one establishment in the town makes a business of sawing, spreading and pressing the horns for those who make the combs and pins.

The pressed horn is first soaked in hot water for two or three days, after which it is shaved and split. The next process is known as "polking," which includes "blanking" and "centering." Briefly stated, a flat piece of horn, little larger than is necessary for the production of two pins, is placed under the polking machine, which cuts out the pins and leaves the blank and center pieces. Such a machine is known as a double cutter; a single cutter cuts out but one pin. As the stock is held by the employee while the machine knife comes down and cuts it, there is some danger of losing a portion of the finger tips through inattention or lack of care.

The pins are then taken to the rounding or "edging" machine, which rounds the edges, and in so doing gives rise to considerable horn dust, most of which, in some factories, is removed by blowers. A double-rounder machine is so constructed that it rounds both the outside and inside of the pin; that is, it rounds off all four corners.

Next, the pins are pointed with a pointing machine. The dust from this machine flies about the operator's face more freely than that from the rounding machine; but the best, and indeed most, of the factories connect these machines with exhaust blowers. From the pointing machines the pins are conveyed to the "tumblers," which are square boxes, lined with spruce, and containing fine pumice stone and water. In these they are revolved for a while, and then they are removed, rubbed, and colored with a mixture which contains usually anilin dyes, red lead, lime and bicarbonate of sodium (saleratus). Finally, the pins are polished, bent and packed.

The processes followed in the manufacture of combs are essentially the same as here described.

In the manufacture of celluloid combs and pins the material used consists of sheets of celluloid, about 20 by 50 inches in area, and from .005 to .175 (generally from .125 to .167) inch in thickness. The sheets are cut into small pieces by means of a long-bladed knife, similar to that used in cutting paper, and the work is known as "slashing." The small pieces are taken to the cutting machines, which cut out the teeth of the

comb. The next process is "polking," in which portions of what is to be the back of the comb are removed. For plain work, dies or cutters are used; and a curved cutting-edge die is stamped through the material, removing the blank or waste pieces, and leaving the comb of the desired shape and design. Some fancy-shaped metal plates are also cut; but, as they are expensive and likely to break, jig saws are generally employed in making fancy openwork backs. When a heavy-backed comb is desired, another thickness of celluloid is cemented on.

The comb is next taken to a machine which bevels the edges. The beveler consists of a flat steel plate, through the center of which is an opening for a small "wing burr," which is placed up through the opening to the height desired. The steel burr, or beveler, makes many revolutions per minute, and on coming in contact with the celluloid gives rise to considerable dust. The dust is, however, coarse and heavy, and most of it flies away from the operator's face. When the burr is put through the opening in such a way as to be mainly on the upper part of the steel plate, and is revolving rapidly, there is a chance of injury to the operator's fingers while holding the comb. For protection against this accident, an ingenious brass collar or "sleeve" has been devised, and is used by some of the workmen.

Circular saws then shape the bottom of the teeth to conform with the bottom of the back of the comb, the teeth having been cut straight in the first process of cutting. The saws are called "bottoming saws," and are generally guarded. A glass front, through which the employee watches his work, protects his face, and especially his eyes, against the chips of celluloid, which are thrown off with considerable force. The dust is coarse, and most of it is removed by efficient blowers.

The next operation is "pointing" the teeth by sand wheels or steel burrs, and the latter go around so swiftly that a very strong exhaust draft does not take away all of the dust. Workmen state that the dust which flies toward the face occasionally strikes the eyes, acting like cinders in this respect; but that it is not inhaled, since the particles are heavy. The sand wheel makes, perhaps, a finer dust; but this is moist and more or less matted together, and interferes little if any with the comfort of the workman. Good blower systems are required by insurance companies wherever blowers may be used to advantage. Dust and shavings are not allowed to accumulate on the floor and elsewhere, on account of danger of fire, celluloid being extremely inflammable.

The backs of the combs are next engraved or carved by hand or machine. The teeth are then "grailed" by a machine which rounds the edges of the teeth. The sides or ends of the combs are then smoothed on "ending" machines or by hand.

All the processes so far mentioned are "bench work," and the employees are men and boys, — mostly men.

The combs are now brought to the "rubbing" room, which may be a separate room or a place partitioned off in one of the workrooms. A typical "rub room" is a long, narrow room, about 40 by 8½ feet and 8 feet high, with a row of windows on the outer long side, and a series of from 15 to 20 small stalls on the other. Each workman stands facing a stall, with his back toward a window, wearing an undershirt, old overalls, a jumper with short sleeves, old shoes and a hat. In the stall in front of him, in a trough, is a mixture of sifted coal ashes and water, over which is a rapidly revolving cloth, or cloth and brush, ball. He holds a comb against the revolving wheel, for the purpose of "rubbing down" the surface so that the comb may better take the finishing processes. With the ball making from 1,200 to 1,400 revolutions a minute, the workman becomes covered with a very fine spray of wet ash dust, and the picture of 15 or 20 men in one of these rooms is far from inviting. The room itself is plastered with ash mud, the window panes are daubed with it, and the employees are sprinkled with it from head to foot.

The odor of camphor, which is a component of celluloid, is brought out by the friction of the rubbing, and adds to the general discomfort.

These rooms are commonly in more or less damp basements, which themselves are undesirable, from a sanitary point of view, as workrooms. In spite of this fact and of the conditions which obtain, it must be said that the majority of employees state of their own accord that they do not mind the work; that many men have done the work for five, ten, fifteen and twenty years or longer, and appear to be in healthy condition; that the men are paid well ($2.50 to $3 a day), and that there is always a supply of men who are glad to undertake the work. It is said that some of these men shift about frequently among the several shops, and are more or less reckless and much addicted to drink. On the other hand, in one of the basement rub rooms a majority of the employees have been with the same firm for from five to thirty years.

Some of the rubbing balls are made entirely of carpeting, while others have layers of tampico grass between the carpeting, since the grass goes more readily in between the teeth. The balls are about a foot in diameter and several inches thick. They are made of carpeting which has been used to some extent, but not much worn, and they are bought already cut out, but they are trimmed in the several factories. Trimming the balls is very dusty work, which is done in some shops in the rubbing room; in others, in a small dust room constructed for the purpose. Some men use respirators or sponges when doing this work, but more do not.

The combs are polished on rapidly revolving balls made of new cotton cloth, with the use of rotten stone and lard oil. This process gives rise to more or less lint and mineral dust; but circular pieces of pasteboard or wooden discs are placed over the wheels to keep the dust from the operatives, and none appears to fly directly into their faces. The balls make from 600 to 700 revolutions a minute, and give a high polish to the combs.

The next process is "bending" the combs, which is done by both sexes, but mainly by women and girls. Steam tables or "heaters" are provided for the work. These are covered with asbestos, on which the employees put blocks or "forms" of the kind desired, containing the combs, which are bent and caused to retain the shape which the particular blocks or "moulds" give them. This is bench work of a not disagreeable kind, although the rooms become considerably heated, and the air in winter weather toward night becomes especially dry and foul. In some factories the combs are bent, or shaped, before being polished.

The final process is polishing with a revolving chamois ball, and this is carried out largely by girls and women, who also do the setting of stones and other ornaments.

A quick and cheap process, which originated within recent years, for obviating much of the hand polishing, is that of using the "acid dip," which gives a brilliant luster, making a comb which is much in demand at the present time. The "dip" consists of glacial acetic acid, with perhaps other constituents, the identity of which could not be ascertained. Generally separate rooms are devoted to the use of this dip, and hoods with glass fronts protect the workers from the strongest fumes.

One unaccustomed to the fumes finds them very irritating to the eyes and somewhat irritating to the nose and throat on entering the room. While the use of the "dip" does not appear to be directly injurious to health, the work is confined to a small room, and the employees, by prolonged exposure to the sickening odor, which, if the windows are closed, is strong, may suffer impairment of general health through interference with the normal appetite and digestion.

Avoidance of using the "acid dip" is a good feature in the industry; and it is noticeable that at least two of the best and oldest firms hold entirely, or mainly, to the old method of handwork, which they know produces far better combs. The dip was introduced to save manual labor, and the result is a cheap grade of product and a process which gives rise to possible injurious effects to the employees engaged therein. The employees are generally men and boys, but in some shops they are women. Usually but two or three employees work in one of these rooms.

In the horn and celluloid industry the tendency is to have the work of soaking stock and rubbing or polishing with ashes — work which in-

volves moisture and dust in the atmosphere of the room — done in the basement; whereas these processes should be carried on above ground, in light, large, airy rooms, preferably, perhaps, in the second story.

The "tumbling" room, where pumice stone and water are used to smooth the pins, is usually in the basement. If the basement is light and well planned, it is a good place for this work; but usually the room is dark, and far from being pleasant to work in. It is true that employees do not stay long at a time in these rooms; but a needed improvement is to have them in a well-lighted place, properly ventilated, with cement floor and a catch-basin connected with the sewer, to provide for thorough cleaning of the room.

A large number, if not most, of the "rubbing rooms," in which revolving carpet buff balls and sifted coal ashes are used, are in basements, which, if not damp, are unpleasant to work in, or in quarters which are open to severe criticism from a hygienic point of view.

An improvement to be strongly recommended is to require, so far as is reasonably practicable, as efficient protection to the health and comfort of the operatives as is provided in the best establishments. In one such establishment the rubbing room is a light, pleasant room on the second floor; and, in addition to many large windows, there is a ventilator pipe 15 inches in diameter. The room is large and without partitions, and all conditions, from a sanitary point of view, are very good.

An excellent feature in this shop is the very large rooms without divisions and partitions, with one exception, viz., a suitable room for turning off the rub or "buff" balls, a room well ventilated and lighted. The employees in this room should use respirators when at work.

In the construction of new buildings for the manufacture of celluloid goods, more attention should be given to fire precautions, so that narrow and dark stairways, poorly lighted corners, long, winding corridors, etc., may be avoided. Rooms should be light, well ventilated and plain, without sharp corners and out-of-the-way nooks, so they can be easily swept, and the collection of celluloid dust and shavings be avoided.

Following is a description of a model establishment, situated in the town of Leominster, and employing from 100 to 150 persons: —

New brick building, finely located, on high ground. Best "rubbing room" in Leominster (carpet buff balls and coal ashes); is on second floor, and not in a damp basement, as many are. In addition to many large windows, there is a ventilating pipe 15 inches in diameter. Room 36 by 136 feet; no partitions. Blowers are provided for the "pointing" machines, not for the rounding machines; this considered unnecessary, as the horn dust is moist, and flies about but little. No acid dip is used in this factory. Only high-grade work done here, by polishing on cotton balls.

Basement room is same size as others, is pleasant, and has cement floor. It has a catch-basin, and the pipe therefrom takes the waste water to sewer. Pumice stone and water on the floor from the tumbling boxes are washed into the catch-basin, which is cleaned out three times in two weeks. The basin prevents the entrance of ashes into the sewer. The room for turning off rubbing and polishing balls is 8 by 16 feet, with cement floor and three large windows. The occupant wears a sponge as a respirator. Fine airy boiler and engine room, 20 by 40 feet, of brick, on first floor, separated from main building; has two doors, one very large, opening outside.

Fire precautions: thermostat system; sprinklers; two lines of hose on each floor of building; twelve fire pails filled with water on each floor; fire extinguishers on first and third floors.

Small wooden storage building, 20 by 50 feet, entirely separate from main establishment. Waste room in same buildings. Toilet rooms in first-class order. No spitting allowed.

### Brush Making.

In the manufacture of brushes, hogs' bristles and vegetable fiber are used. The bristles, when not bought already prepared, are in a very unclean condition, and require to be boiled several hours, dried in steam driers and bleached. They are then "dressed" or combed by machinery, and mixed. When unboiled bristles are combed, considerable irritating dust is given off. In the process of setting into handles in the manufacture of varnish, paint and kalsomine brushes, a cement consisting of wood alcohol and shellac is employed; but for shaving brushes a cement of rosin and linseed oil is used, and this is kept fluid by means of electric or non-luminous gas-flame heaters, provided with hoods which communicate with flues.

The 7 brush factories visited in Boston, Lowell and Springfield were found to be adequately lighted and fairly well or excellently ventilated. The machinery was well guarded. The general conditions were found to be beyond criticism, and the health of the employees appeared to be fair or good. The great majority of employees in this industry are women and girls, and in one of the factories several hundred are constantly at work.

### Pearl Button Making.

In the manufacture of pearl buttons, machines with cutters resembling surgical trephines cut disks out of shells, with evolution of much fine dust. Much dust arises also in the several processes of drilling, turning and polishing; but it is light, and, in well equipped factories, is effectually carried away by exhaust blowers. Polishing by the wet process is unattended by dust.

Two pearl-button factories visited showed no objectionable conditions whatever. Light, ventilation and general health of employees were reported as good.

## The Paper Industry.

The manufacture of paper is one of the leading industries of Massachusetts. In fact, while according to the census of 1900, under the head of "Paper and Wood Pulp," Massachusetts is second only to New York, in the manufacture of paper (apart from wood pulp) this State leads all others. In the course of this investigation 80 paper mills, situated chiefly in the western half of the State, almost one-third of them being in the city of Holyoke, were visited.

The materials from which paper is made include rags, burlap, old paper and wood pulp. Rags are derived chiefly from foreign countries, from which they are imported in bales compressed by hydraulic power. These are opened at the mill, and the contents are put into a closed, box-like structure, known as a "beater" or "thrasher," containing a large wooden roller with iron "fingers," which revolves several hundred times per minute. This separates the rags and shakes them thoroughly, giving rise to much dust, which falls between the long strips of iron grating beneath the roller into a specially constructed receptacle, which may be cleaned out by hand or by means of an exhaust fan and dust pipe. During this process more or less dust commonly escapes into the room, and in some instances the amount is very great, partly because of the very dirty character of the rags handled. From facts gathered with reference to this process in 80 establishments it appears that, with the usual grade of stock, no matter what kind of "duster" or "thrasher" is used, and in spite of exhaust fans and dust pipes, some dust will escape. With high-grade stock certain dusters work very well, while with low-grade stock the results are far from satisfactory. Some very high-grade clean stock gives off little if any dust.

In some mills the dust from the thrashers is collected and baled. This work is exceedingly dusty, and the men who perform it are provided with respirators, which they appear to use with far less reluctance than is shown by those to whom they are supplied in other dusty trades.

From the duster or thrasher the rags are conveyed by hand or through a chute to the sorting room, where they are sorted on tables with box-like tops provided with bottoms of wire netting, through which dust and fine particles escape to receptacles below.

Two persons (men or women) work at each table, one on each side, picking over the rags, cutting off and throwing aside all buttons, whalebones, rubber, buckles, woolen and silk materials, and other objects and substances which should be removed. They may sit or stand, as they prefer, but some of the women assert that they can work better and faster standing. Caps or cloths are worn, to protect the hair from dust.

The air of some sorting rooms is more or less dusty, especially if, as not rarely happens, the dusting machines are situated in an adjoining room with more or less permeable partitions.

The rags go next to the rag "chopper" or cutter, which cuts them into pieces of a certain length, and thence they pass to another which cuts them still smaller. These machines give rise to much dust, the amount varying with the kind of stock used, the type of machine and the means employed to prevent the escape of dust.

From the choppers the material is carried by a conveyor belt to the kettle room, where it is cooked. This room contains a very large revolving boiler, known as a "rag rotary," capable of holding four tons or more of rags. In this boiler the rags, to which is added a certain amount of lime, are kept under steam pressure for a while, and when they are thoroughly "cooked," the boiler, so placed that its doors are nearest the floor, is opened, and the rags fall out; then they are shovelled into box trucks and carried to the "washer."

Instead of a "rag rotary," the open cooking tub is sometimes used. This has a false bottom, which is raised when the cooking has proceeded sufficiently far, lifting the stock and permitting the water to drain back.

In the washing machine the rags are treated with large volumes of clean water, which enters at one end continuously. The stock is guided by a paddle roll around the periphery of the tub to the farther end, where a "washing drum" lifts the dirty water out through a pipe connecting with the sewer.

When the stock is washed sufficiently it is next bleached by means of chlorinated lime ("chloride of lime"), mixed with water in a large tank. Then it goes to the "drainer," which is a large brick vault with a floor of perforated tiles, the perforations being of sufficient size to permit the liquor to drain through and leave the paper stock. When the latter is sufficiently dry it is shovelled out and put into a beater, with perhaps some wood pulp. This machine contains a large roll, bearing knives running on a bed plate, between which and the roll the stock travels while undergoing comminution.

From the beater the stock is emptied into a large tank, known as the "machine chest," where it is thoroughly mixed, diluted and stored, and from which it passes as needed to the paper-making machine.

Old paper is received at a paper mill in the form of bales, which are opened by men and sorted by women and girls. It is conveyed to the "duster" on an endless belt, and in this machine it is freed from dust and torn into pieces by means of revolving wooden rolls, bearing iron pins. The pieces of paper are sorted over like rags, but are not put through the choppers, passing from the dusters to an open cooking tub.

From the box of the paper-making machine the paper stock, diluted with water, is run on to "screens," which consist of series of brass plates with openings one-hundredth of an inch wide. The excess of water is drawn through by suction, leaving the paper stock in the form of a long sheet, which passes through rolls which remove more water, then through "press rolls" and then to drying cylinders, from which it is run to calendars which smooth it, reelers which wind it in rolls, and slitters which cut it to the desired width.

There are various other processes followed in the manufacture of paper, but none of them has any features of special hygienic importance, except exposure to high temperatures and to air saturated with moisture.

From the above description it will have been noted that, from the opening of the bales of rags or paper to the cooking process, the various steps involve exposure to varying quantities of dust, the greatest amount being given off in the earliest operations. It appears that, no matter how constructed, how carefully enclosed, how well provided with blowers and dust flues, a certain amount of dust is inevitable in the rooms where the thrashers and choppers are installed and operated, excepting when unusually clean materials are being handled. If the machines are loosely sheathed or are not adequately equipped with dust-removal devices, the amount given off may be considerable to enormous, according to material. Unless the most dusty rooms are tightly partitioned off from other less dusty ones, — as, for example, a thrashing from a sorting room, — the amount of dust in the air in the latter must necessarily be augmented. In a number of the mills visited the air of the whole rag department was observed to be filled with dust and lint.

The character of the dust brought in with rags varies considerably, as would naturally be surmised from their many different places of origin. Some of the employees state that while at first they suffered from sore throat, cough and loss of sleep, after a time they became so habituated that only an occasional bale causes any discomfort. In some mills it was observed that the dust was far more irritating than that met with in others; especially is this true of those in which burlap is used. Some men assert that the dust from rags of one color may be worse than that from the same kind of cloth differently dyed. Some say that some bales are sickening in their effects, even to old hands.

Of the thrashing rooms visited, a very small number, in which the machines were exceptionally good and where the cleanest rags were handled, showed no dust; somewhat more, equipped with the same grade of machines and working on the same kind of material, showed but little dust; and the remainder showed considerable to much. About 11 per cent. of the sorting rooms were dustless, about 25 per cent.

were not very dusty and the balance showed considerable to much. Of the cutting rooms, about 7 per cent. showed little or none and the remainder considerable to much. In a number of establishments sorting is conducted in large, airy, well-lighted, mechanically ventilated rooms; but in some of these cutting machines have been installed, and they create considerable dust. Indeed, in the matter of separation of the several processes mills vary; in some the duster and cutter machines are installed in separate rooms, in some they are in the same room.

In a majority of the mills visited a portion of the employees are exposed to an excessive quantity of dirt, dust and lint; and in most of this majority the persons so exposed show not a few who are pale and sickly in appearance.

In 19 mills girls under eighteen years of age were noted as being employed, in no great numbers, in rooms which were very dusty.

In the department where the paper is actually made there is no dust, but the temperature is sometimes excessive, and the air saturated with moisture. The latter condition is not only promotive of discomfort, but exposes the paper to damage through condensation and dropping, wherefore, exhaust ventilation is commonly resorted to.

The paper industry, being one which exposes its followers to every kind of dust and dirt which can be carried in rags, is naturally looked upon by many as a dangerous trade. It is unfortunate that it is impossible from statistics available to determine in what relation this industry stands to others of the dusty occupations. The death certificates of the city of Holyoke, the center of the business in this State, were examined; but they proved to be too indefinite for use, since the terms "paper worker" and "mill hand" are commonly applied to all employees, whether engaged in the dusty or non-dusty processes. Comparing, however, the death rates from tuberculosis, pneumonia and bronchitis during the years 1901, 1902, 1903 and 1904 with those of the State at large, it was found that the Holyoke rates were under rather than over the average.

### Emery and Corundum.

Corundum is an extremely hard oxide of aluminum, used for polishing; emery is a very hard, granular variety of corundum, containing a small amount of magnetite or hematite. Ground to powder, these substances are used for polishing, grinding or abrading stone, metal, glass, etc. In the crushing and grinding process, which is conducted in machines more or less completely enclosed, considerable very fine dust is given off, in spite of efforts based largely, it must be said, upon considerations of economy. The dust is peculiarly irritating, causing burning and smarting in the nose and throat in the case of those not habituated

to its inhalation. After sifting and grading according to fineness, the product is stored in appropriate compartments, from which it is taken as needed, with evolution of dust.

Wheels and stones of various shapes and sizes are made from the ground material mixed with one or more cohesive substances, which include clay, glue, shellac and certain others. The operation of mixing is attended by much dust. The mixture with clay, after suitable moistening and molding, is fired in kilns, and the resulting stones and wheels are much harder than those made with glue, shellac, etc., but the latter are more elastic and less likely to break. The wheels in the rough state are set up and revolved rapidly and cut down to proper size and smoothness with a steel tool, and in this operation great clouds of dust are given off in all directions. Some of this work is done by the wet method, which reduces dust production to a minimum. The completed wheels are finally tested in a metallic compartment, where they are run at an exceedingly high rate of speed; and those which pass the test without breaking are considered safe, since they are never again subjected to the same strain in any work in which they may be used.

This line of industry, being one of the dustiest, and the dust being of a particularly irritating kind, may justly be classed among the trades which are intrinsically dangerous to health; but, as is the case with other dusty occupations, few of those employed can be induced to wear respirators. In the largest of the 5 establishments visited, employing more than 300 men, only an occasional workman was observed wearing this means of protection. In 4 of the 5 the ventilation, apart from the dust, was noted as fair, and in the largest of them ventilating fans are in use in the dustiest parts of the factory. In all the light was noted as good or fair, with the exception of the one which was noted as poorly ventilated. This one, however, is a very small establishment, in which 2 men do all the work, and buys its emery ready crushed.

In the largest factory lunch rooms and lounging rooms are provided for the employees.

While the great majority of the employees in the several establishments appear to be well and strong, a notable proportion present a pale and sickly appearance. The habit of promiscuous spitting is indulged in to a very considerable extent.

### Sandpaper Making.

Sandpaper is made by spreading sand or "garnet" on paper smeared with glue, and drying the product over steampipes. "Garnet" is a fine gravel obtained in the Adirondacks. It is ground, sifted and graded by machinery provided with hoods and exhaust pipes; but in the only factory of this kind visited there was, in spite of the working of a 48-inch

exhaust fan, to which the pipes are connected, a great deal of fine dust in the air. Those exposed to this dust are urged to wear respirators, but they prefer not to do so; and, in spite of their refusal, all of the 80 or 90 employees appear to be in good health. The lighting and ventilation of this establishment may be rated as only fair.

### Stone Cutting.

The stone-cutting industry is justly classed as one of the dangerous trades. It requires of its followers great strength, for the hammers are heavy and the blows are struck with considerable force, and good workers work fast. In the processes which do not involve the use of hammers, but of machine tools, the work is very laborious, and is not suited to those of poor physique.

It is preëminently a dusty trade, and the workmen are, therefore, exposed to the danger of inhaling nonabsorbable and irritating particles of mineral matter. Accidents to the eyes from flying chips are also very common, but they are generally less serious than those due to fragments of steel from the tools employed.

Of the various kinds of stone dust, granite is regarded as more injurious than marble, and soapstone the least of all; but different granites vary in this particular, some yielding a much finer dust than others, on account of differences in texture.

The greatest amount of dust comes from the surfacing machines, which are operated with compressed air. The tool is either a large hammer or an instrument which presents four smaller separate faces. Sometimes a bushing hammer, made of thin, chisel-like blades bolted together, is used; this creates the finest dust of all.

The men who operate the surfacing tools rarely wear masks, but many chew tobacco and spit, in the belief that the practice serves to protect them from the effects of the dust to which they are exposed. Some protect themselves from flying chips by means of wire screens placed about the hammer; some wear wire masks and some wear glasses. By a union regulation, surfacing is done in the open sheds in the yard.

While the operation of smoothing cannot be done by the wet process, on account of clogging of the tools with the pasty material which would thereby be produced, polishing is conducted with the application of water, which prevents the evolution of dust. The sawing of granite and marble into slabs is conducted ordinarily by the wet process, and is therefore unattended by dust; but soapstone sawing and cutting for joints is frequently done dry, and with the evolution of much fine dust. Turning in lathes is conducted in the wet way, and is dustless.

In general, the granite-cutting business is conducted in large, open

sheds, some of which have roofs which can be lifted; but even there and in the open yards the workmen are exposed to clouds of dust, especially those who operate the pneumatic tools. Work on marble and soapstone is, however, conducted in doors in the few establishments found.

"Stone cutters' consumption" is very common, especially between the ages of forty and fifty; and it is a well-established belief among those employed that it is the careless and those who indulge in alcoholic beverages who, as a class, are most likely to become infected.

Of 343 deaths which occurred in the city of Quincy among stone cutters during a period of about sixteen years, no fewer than 142 (41.4 per cent.) were due to pulmonary tuberculosis, 41 (12 per cent.) to other diseases of the lungs, 44 (12.8 per cent.) to diseases of the heart, 24 (7 per cent.) to violence and 92 (26.8 per cent.) to all other causes. Excluding accidents, the percentage due to tuberculosis was 44.5. These statistics show even more strikingly than those quoted in the report submitted two years ago the dangerous character of this occupation. Therein it appears that, of a total of 30,000 deaths among stone cutters, tuberculosis was the cause in 28.57 per cent. It must be said, however, that the average age at death of the victims of the disease in this industry, so far at least as the Quincy records show, is somewhat high (47.8 years), but it is to be borne in mind that the calling is one which is not open to the naturally weak, and that many of those who become incapacitated through infection drift into other lines of industry in which physical strength is not so essential, and hence at death are not returned as belonging to this class.

In the course of this inquiry there were visited 85 establishments devoted to this industry, and employing about 2,600 men: 5 in Boston, 4 in Milton, 5 in Milford, 68 in Quincy and 3 in Rockport. As stated, most of the work is done in the open air, or in sheds with open sides and movable roofs; but under the best of conditions, where the operations are conducted necessarily without the use of water, there exists the danger of dust inhalation, which apparently cannot be reduced by means of appliances commonly used in in-door, dusty occupations. Unless the workmen can be induced to protect themselves against dust inhalation by the use of respirators, which aids to maintenance of health are declined commonly by reason of the discomfort which their employment entails, there appears to be little hope of removing this industry from the list of dangerous trades.

In a large number of the yards and sheds visited a considerable proportion of the employees showed various evidences of impending or existing ill health.

### Glass Cutting and Polishing.

Operations which cause glass dust in the air are recognized as especially dangerous to health, such dust being quite as irritating as steel dust, if not more so. This being the case, glass cutting and polishing are conducted with a minimum of danger in the wet way.

In cutting, the pattern is marked out with red lead or with graphite, and then the object is held against a rapidly revolving steel wheel upon which fine quartz sand and water are dropped continuously, or upon a wheel of fine emery and corundum. When the pattern has been cut out, the glass is plunged into hydrofluoric acid in lead tanks, connected with the exhaust pipe of a steam-propelled blower. This smooths the cut surfaces, but acts on the uncut parts to such an extent as to make polishing necessary. This is done with pumice or rotten stone and water or oil on revolving brushes, and putty powder or rouge and wax on wooden wheels. The use of oil or water serves to prevent dust, and the employment of wooden shields protects the worker from being spattered with the mixture of water or oil and glass powder and other materials thrown off in the process.

For successful work good light is very necessary, and in this respect all 5 of the establishments visited were found to be beyond criticism. The conditions as to ventilation and toilet arrangements were found to be equally commendable.

All cutting and polishing is done by the wet method, and in no instance was any dust perceptible.

In 2 of the establishments in which glass blowing also is carried on the employees are necessarily exposed to high temperatures and to the possible danger which resides in the use of blowpipes, which are introduced indiscriminately into the blowers' mouths. Otherwise, no objectionable features were noted.

The number of persons employed in the several factories ranged from about 30 to several hundred. As a class, they appear to be of a rather high order of intelligence and to enjoy good health.

### Manufacture of Optical Lenses.

In the larger of the 2 establishments visited where optical goods are manufactured, about 600 persons are employed; in the smaller the number of employees is below 50. In both places lenses are ground by machines with the aid of rouge (iron peroxide), but, as the grinding is done by the wet process, no dust is created. The use of rouge on cloth polishing wheels, however, gives rise to a certain amount of dust, which covers the hands, clothes, and to a considerable extent the faces of the polishers, in

spite of hoods and exhaust fans. In the larger a laundry is maintained for supplying the operatives with clean overalls.

In both establishments the light and ventilation are good and the sanitary arrangements are satisfactory, and in both the operatives appear to be in good health.

MANUFACTURE OF MACHINERY, MACHINE PARTS AND METAL SUPPLIES.

In the manufacture of machinery and metal supplies there are several operations which involve exposure to dust fumes, vapors or extreme heat. These include making castings, cleaning and smoothing, grinding and polishing, and scaling.

*Casting.* — In casting iron and brass the workmen are exposed to extreme heat; and in the case of brass to heavy fumes, which are evolved as soon as the molten metal begins to be poured into the moulds.

*Cleaning and smoothing Castings.* — Castings are cleaned and smoothed in various ways: by means of emery wheels and revolving wire brushes, by being rotated in "tumblers" or "rattlers," by chipping with pneumatic chisels and by means of a sand blast.

The use of emery wheels and revolving wire brushes gives rise to much dust, and, if the wheels are not equipped with hoods and fans, the air becomes thick with it. Some operatives wear glasses to protect their eyes from the escaping dust.

In the use of the sand blast the operative wears a canvas hood and mask resembling a diver's helmet, and is supplied with air through a small pipe which enters at the top. Rooms where this work is done are filled with flying sand and dust, the greater part of which, in some establishments, falls between the iron pipes, of which the floor is constructed, to the rooms below.

When castings are smoothed by being rotated in "tumblers" or "rattlers," unless these are tightly built or equipped with hoods and blowers, much dust and dirt are given off.

*Scaling.* — In the removal of scales castings are wet with dilute sulphuric acid. The fumes arising in this process and while the castings are draining are very distinctly irritating to the nose and throat. Small castings may be dipped into a tank set into the floor, but larger ones are wet by having the acid thrown over them on the floor, which latter is so constructed as to permit the excess of acid to drain back into the tank.

*Grinding and Polishing.* — In these processes the amount of dust which arises varies according to the kind of work and provisions made for dust removal. Light polishing on emery wheels equipped with good hoods and adequate exhaust ventilation gives rise to but little dust; while heavy grinding on large emery wheels may create a great deal, in

spite of the best of hoods and most powerful of blowers. Automatic grinding machines, completely enclosed and well equipped with hoods and blowers, expose the workmen to little or no dust.

Enormous amounts of fine steel and emery dust are given off in the grinding of "tops and flats" (surfaces, either curved or flat, covered with stiff steel wires like a brush), unless the emery cylinders used are adequately equipped with exhaust ventilating appliances.

While the nature of some of the processes is such as to warrant classification of this industry with the dangerous trades, the conditions under which the work is done are very largely responsible for the injurious effects on the health of the employees, and these conditions are to a considerable extent avoidable or at least susceptible of improvement.

*Factories visited.*

The 24 establishments included under this heading are divided as to the character of their products as follows: —

| | |
|---|---|
| Cotton machinery (Hopedale, Lowell, Whitinsville, Taunton and Fall River), | 6 |
| Tanners' machinery (Peabody), | 2 |
| Paper machinery (Fitchburg and Worcester), | 3 |
| Shoe machinery (Beverly), | 1 |
| Drilling machinery (New Bedford), | 1 |
| Confectioners' machinery (Springfield), | 1 |
| Sewing machines (Orange), | 1 |
| Rivets, screws, bolts, nails, tacks (Quincy and Worcester), | 3 |
| Valves and hydrants (Boston and Holyoke), | 2 |
| Miscellaneous (Boston, Canton, Taunton and Worcester), | 4 |

The number of persons employed in these factories ranges between 12,500 and 15,000, and of this number more than half are engaged in making cotton machinery.

*Light and Ventilation.* — In these 24 establishments the light varied in the different departments from good to moderately or distinctly bad, but in none was it found to be generally poor or bad.

With two exceptions, the ventilation of rooms other than those in which processes are conducted which give off dust or fumes was found to be at least fair. In one there was no provision for fresh air, and the air was distinctly foul; in the other the air introduced was the heated, already foul air of another department.

In the departments in which ventilation and good light are most necessary, namely, those in which dust and fumes are given off, one or the other was found commonly to be lacking. Adequate ventilation and

suitable devices to promote the removal of vapors, fumes and dust would go far in removing this industry from the category of occupations dangerous to health.

Following are some of the objectionable conditions observed in the cotton machinery establishments: —

*Casting Brass.* — In one instance the only escape for the gases and fumes is by way of the doors and windows, there being no roof ventilation.

*Tumbling Castings.* — In one place some of the tumblers are provided with blowers and good exhaust draft, and create practically no dust; while others not so equipped give rise to considerable dust, to which 70 men in a badly lighted basement are exposed. The conditions here are in marked contrast to those obtaining in another establishment, where the tumblers are of very tight construction, adequately ventilated by fans, and productive of no dust whatever.

*Grinding and Polishing.* — In one room 28 emery wheels and grindstones are in use, the latter provided with heavy iron hoods which cover them almost completely; but the emery wheels, being quite unprotected, cause the air to be exceedingly dusty. In another, occupied by 70 workmen, there are 25 emery wheels which formerly were equipped with hoods and large-sized exhaust pipes, most of which have now, however, been removed. The air of the room is exceedingly dusty, and about one-tenth of the occupants look pale and sickly.

*Grinding "Tops" and "Flats."* — In one place the emery cylinders are not provided with hoods; the amount of steel and emery dust in the air is very great. All of the men look pale and sickly, and all complain of the irritation of the air passages by the dust.

*Dipping Castings.* — In one place this work is carried on in a badly lighted basement room, and all of the 7 occupants appear to be in bad physical condition.

*Cleaning and smoothing Castings.* — In a poorly lighted room, in which 12 emery wheels are without any sort of dust-removing apparatus whatever, 25 men are engaged in the dirty, dusty work of "snagging" or "chipping."

The 2 tanning machinery factories showed but few objectionable conditions. Both are fairly well lighted and ventilated, and the employees look healthy. The brass foundry of one is low studded, and lacks suitable means for the escape of smoke and fumes; but the tumblers are of very tight construction, and are situated out of doors.

In one a few emery wheels are unprovided with hoods and blowers.

The 3 paper machinery factories visited are well lighted, and in general at least fairly well ventilated. The employees look healthy. In one factory the type of tumbler used is such as to merit especial mention,

because of its generous proportions and effective dust-removal apparatus. The machine shop departments are above the average in all respects, but the brass foundry is not ventilated. The brass foundry of one of the others is reasonably well ventilated, but the fumes which come off in clouds during casting are very troublesome and do not pass readily away.

In the other factories of this class the conditions observed were mainly commendable. Those which were found to be objectionable include the following: —

*Brass Casting.*

*A.* A very large amount of coal gas gains access to the casting room, owing to defective draft. This is very troublesome to the men working near the furnaces.

*B.* The air of the brass foundry is heavy with fumes, especially in winter, no mechanical ventilation being installed. The 8 men at work assert that they have occasional attacks of poisoning ("brass founders' ague"), which they treat by remaining at home and "sweating it out of the system."

*Cleaning Castings.*

*A.* Tumbling castings in a poorly lighted, unventilated room, the air of which is filled with dust and plumbago from the castings. The 8 men present are black with this dirt.

*B.* Room, with 6 occupants, so thickly filled with dust and dirt that even the four or five gaslights (the sole means of lighting) cannot be distinguished across the room, and a man cannot be made out at a distance of four feet. The dust and dirt come from ten loosely constructed tumblers. Means of ventilation: a few small openings in the roof, two small windows and a door. In the same establishment, a room with 40 occupants is very badly lighted, and, in spite of blowers and dust flues, is filled with emery and other dust. Also, an attic room, occupied by 9 men, is badly lighted, foul and exceedingly dusty, in spite of hoods and blowers. Chipping and snagging is done in an exceedingly dusty, badly lighted room, in which there are 12 emery wheels without hoods or blowers.

*Dipping Castings.*

In one establishment the castings are dipped in a small, badly lighted, unventilated room, the air of which is exceedingly disagreeable from concentration of the fumes.

*A Model Establishment.*

Following is a partial description of a model establishment in which are employed many hundreds of men: The comfort of the employees is carefully looked after. The rooms are light, and not crowded. Lunch rooms are provided, and food can be purchased at reasonable prices, or it can be brought in, as desired. A series of bath rooms is provided for men, and another for

women. The toilet rooms are large, clean, light and properly ventilated. The iron foundry is very high; it is light, and amply ventilated through the roof. The tumblers and emery wheels are provided with hoods and blowers which are effective, and there is practically no dust. The rooms in which castings are dipped are properly ventilated, and all fumes are effectively removed. All of the machinery is well protected.

### Iron and Steel Foundries.

Of 14 iron and steel foundries in which castings of all sorts are made, situated in Boston, Chelsea, Dighton, Fitchburg, Greenfield, Lawrence, New Bedford, Orange, Springfield and Worcester, 7 showed generally poor conditions as to light, ventilation and dust removal. One showed commendable conditions throughout. This establishment employs 250 persons, in well-lighted, adequately ventilated and practically dust-free rooms, and is engaged in the manufacture of elevators. Another, in which 150 men are employed, in a well-lighted, and, apart from dust, adequately ventilated building, has a department in which the castings are sand-blasted, which is so heavily impregnated with flying sand that it is impossible to see across the room even in bright sunlight. The sand gets into the mouth, nose and eyes, and the employees suffer considerably from soreness of the last-mentioned organs. In another, in which about 1,500 employees are engaged in the manufacture of pumps, each sand-blast room has small windows at the top, openings in the roof, and a large flaring hood in the center, with upward-suction draft. The castings are placed under the hood and the sand-blast is played on them, the operatives wearing helmets with fine wire inserts to protect the eyes, and cloths underneath the helmets to protect the nose and mouth.

### Stove Foundries.

Of the 9 stove foundries visited, in Chelsea, Fitchburg, Gardner, Hyde Park, Taunton, Watertown and Westfield, 4 presented moderately bad and 1 distinctly bad conditions, while 1 was found to be conducted under conditions which may be regarded as sanitarily ideal. This establishment employs about 1,200 men, in well-lighted and adequately ventilated buildings. The room in which castings are cleaned and tumbled is large, light and airy, and has a tight cement floor. In the polishing room the emery wheels are well equipped with hoods and exhaust ventilation; but the men, unmindful of the protection provided, habitually remove the hoods, and become covered with emery and iron particles. The brass-casting room is very high studded, and is ventilated so well that the fumes and vapors are rapidly removed. The iron-casting department, occupied by 300 men, is very large and of good height, and is very effi-

ciently ventilated. A large wash room, with cement floor, lockers, hot and cold running water and numerous shower baths, contributes greatly to the promotion of personal hygiene and comfort of the employees.

Among the other establishments of this class, 4 are poorly lighted in most departments, the tumbler rooms and polishing departments are exceedingly dusty, and most of the emery wheels are unprovided with hoods and mechanical exhaust ventilation. Another employs 275 men, in low-studded, poorly lighted, unventilated buildings, in which there is no attempt to remove the dust arising from the processes of polishing and buffing by hoods and exhaust ventilation. In the tumbling room the dust is so thick that objects a few feet distant cannot clearly be made out. Many men refuse to work in this establishment in the hot months, on account of the excessive heat and general discomfort.

### Brass and Iron Foundries.

Six establishments of this class, situated in Fall River, Fitchburg, Gardner, Newburyport, Pittsfield and Woburn, were visited, and in 3 of them the work of cleaning castings by scratching and tumbling was found to be done in small, poorly lighted and ill-ventilated rooms. In 2 the brass-casting departments were found to be unprovided with roof ventilation, and the rooms were heavy with fumes; but in 2 others the light and ventilation were most commendable, and in 1 of these there is good roof ventilation, and the furnaces in which the composition is melted have special flues and exhaust fans for the removal of smoke and fumes.

### Brass Foundries.

With few exceptions, the conditions as to light, ventilation and protection from dust observed in the 35 brass foundries visited, in Boston, Fitchburg, Williamsburg, Holyoke, Lawrence, Lowell, New Bedford, Orange, Peabody, Salem, Springfield, Westborough, Westfield and Worcester, were very satisfactory. In one establishment 5 men were found to be exposed to very irritating fumes, which escaped slowly by the windows; in another 30 men were similarly exposed in a room of fair size, but with no means of ventilation; in several others a smaller number of men were at work in rooms with no outlets for fumes.

### The Cutlery and Tool Industry.

From a sanitary point of view, the one important part of this industry is the reduction of the surface of the article in process of manufacture from the roughness of the original casting to the smoothness and brilliancy so necessary and desirable in the finished product. This involves

successive treatment by wet grinding, dry grinding on emery and corundum wheels, and polishing with rouge on buffing wheels. Each of these processes, even that of wet grinding on large, coarse and finer stones, causes to be cast into the air large amounts of fine dust, made up of very fine particles of steel and of the abrasive substance. In establishments properly equipped and conducted, provision is made to reduce the danger of this dust to a minimum by means of hoods connected with a system of exhaust fans or blowers. In spite of the precautions taken to protect their health, a very large proportion of grinders recklessly remove the hoods, and thus expose themselves unnecessarily to this especially dangerous form of dust. They assert that they prefer freedom of movement, with dust, to the protection afforded by hoods.

Concerning the dangerous nature of this calling there is no dispute. It is notoriously one of the most dangerous of trades, the prevailing disease among its followers being tuberculosis, which among this class is known as "grinders' asthma" and "grinders' rot." The employees readily admit that grinding and polishing are dangerous, but they do not agree as to which of the two is the more dangerous.

The workmen are not, as a class, long-lived; indeed, the nature of the work is not compatible with longevity, and a person entering upon it in middle life is unlikely to follow it many years. Whatever the age at which the trade is taken up, a man in sound health who has followed it a few years is an acknowledged rarity. A study of the death returns of the city of Northampton, which is one of the centers of this industry, for the past twelve years, yields facts which can be interpreted in only one way. During this period tuberculosis is given as the cause of death in no less than 54.5 per cent. of those whose occupation is indicated by "grinder" or "polisher," and in 45.4 per cent. of those designated generally as "cutlers;" and, of the latter, 36.4 per cent. died of pneumonia. Taken together, the "grinders," "polishers" and "cutlers" returns show that, during this period, diseases of the lungs were responsible for 72.73 per cent. of their mortality. As was shown in the preliminary report on this industry, the tuberculosis death rate for cutlers in Northampton is four times as high as that for the entire adult male population.

Twenty-eight cutlery and tool-making establishments were visited. These are widely scattered, but the majority are situated in the western half of the State. The places visited vary in size, from those employing less than a half-dozen to one employing about 250.

In general, the light was noted as fair or good; but the ventilation was observed in many rooms to be very defective, while in others it was noted as adequate.

Of 3 establishments engaged in the manufacture of machine knives, 2

were found to be well lighted and properly ventilated, and the wheels equipped with efficient hoods and blowers. In a basement room of the other were found 4 large emery wheels not provided with blowers, and the air was very dusty.

Of 2 engaged in making saws and machine and belt knives, 1 has effective blower ventilating apparatus, and is only slightly dusty; the other is not so equipped, and the men are much exposed to dust.

Eight small shops devoted to saw filing and cutlery grinding presented no objectionable features.

Two razor factories showed objectionable conditions. In one is a room containing between 20 and 30 emery wheels without blowers; the air was full of emery and steel dust. The other occupies a large, new building, which is well lighted excepting in the basement, where 40 girls are employed; and adequately ventilated excepting in two buffing and polishing rooms, in which 19 men and 4 boys are exposed to considerable dust.

Of the remaining cutlery establishments of various sizes, 5 are properly lighted and adequately ventilated, and present no objectionable features. In 4, which employ respectively 62, 66, 37 and 250, hoods are provided; but the employees remove them, in order to see better and to have more freedom of movement, and the grinding and polishing departments are consequently very dusty. In the largest of these the hoods are removed in spite of orders to the contrary, and the 36 occupants evince no interest in this danger to their health. In other departments of this same factory there is much dust, in spite of efforts on the part of the proprietors to reduce its amount.

Four establishments, one small and unusually clean and well kept, one employing 89 men, another employing 27 and the fourth employing 11, have no hoods over the emery wheels, and this is their only objectionable feature. They are naturally dusty.

In all of the factories of this class the machinery was found to be effectively guarded, and the water-closets to be in at least fairly clean condition.

Of this industry it may fairly be said that, even where employers show a commendable inclination to safeguard the health of their workmen, a large proportion of the latter show a reckless disregard of their own interests.

### Manufacture of Agricultural Tools and Implements.

In the tool and agricultural implement industry the processes followed in making the metallic parts are essentially the same as in the manufacture of machinery and machine parts; but in addition to these are several which enter into the making of handles of hard wood. A

wood called "coca-bola" is considerably used, and its dust is peculiarly pungent and irritating, causing coryza and not infrequently troublesome dermatitis. Some persons suffer from coryza for a week or two, and then become accustomed to the dust; but others never acquire such immunity, and are obliged to discontinue work in this department. Wood alcohol varnishes are commonly used on the handles, and give off their characteristic fumes.

Twelve factories, situated in Athol, Boston, Fitchburg, Greenfield, Holyoke, Easton, Montague and Worcester, and employing approximately 1,000 men, were found to be generally well lighted, and, apart from dust, fairly well or adequately ventilated. In each factory the employees, with few exceptions, and these in the departments where the dust is most abundant, appeared strong and healthy. Not one factory presented even moderately bad general conditions, and in 3 the conditions were found to be sanitarily ideal, the rooms being well lighted and thoroughly ventilated, the polishing and buffing wheels provided with efficient hoods and blowers, and the acid dipping rooms with hoods and good exhaust ventilation.

### Manufacture of Firearms, Bicycles, etc.

Seven establishments, devoted to the manufacture of firearms, bicycles and skates, were visited, in Chicopee, Fitchburg, Springfield and Worcester. In the majority of these the light and ventilation were found to be good, but in certain departments, where the polishing of metal and wooden parts is carried on, the amount of dust in the air was found to be excessive. In one of the factories the only objectionable conditions observed are the exposure of 16 men, working in a room 40 by 45 feet, to large amounts of very fine black walnut dust; and the exposure of 12 men in the steel-bluing room, 40 by 30 feet, to the fumes of burning charcoal. In another not only was there considerable wood dust, but three of the emery wheels were unprovided with blowers and exhaust fans, so that there was emery and steel dust in addition.

In one establishment, in which the light and ventilation are poor and in which the grinding and polishing rooms are so dark as to require the use of illuminating gas all day, the dust was observed to be adequately removed by means of mechanical ventilation; but in the buffing rooms there was much rouge and other dust in the air, in spite of the hoods and blowers.

In another establishment the hoods and exhaust fans were found to be not wholly efficient in removing black walnut dust, nor in preventing the escape into the air of emery and steel dust.

In one establishment, of considerable size, every condition observed

was found to be worthy of commendation. The light and ventilation are good. The buffing wheels are well equipped with hoods and blowers, and they give off practically no dust or lint. There are the best of modern washing facilities, toilet arrangements and clothes lockers.

### Galvanizing Iron.

In galvanizing, the iron is first "pickled" in a vat of weak acid (hydrochloric and sulphuric), which removes scales and prevents oxidation during the next process, — that of immersion of the pickled iron in a tank of molten zinc. As soon as the two metals come in contact, acid fumes are given off, and frequently cause considerable discomfort, which is greatly augmented by the dense fumes which arise from throwing sal ammoniac into the zinc before and during the withdrawal of the iron. These fumes are so irritating to some, especially those with bronchial troubles, that they are obliged to discontinue the work.

Of 3 galvanizing establishments visited in Boston, 1 was found to be poorly ventilated and badly lighted, but the other 2 presented no objectionable conditions, the ventilation being so effective that the fumes are drawn off through air shafts with great rapidity. The workmen in all 3, about 60 in all, appeared to enjoy good health, and asserted that, beyond sneezing and coughing at times, they suffer no inconvenience or discomfort.

### Wire and Wire Cloth Making.

In the open-hearth steel department of a wire-drawing establishment the men are exposed to extreme heat, and heat exhaustion is said to be the commonest accident in summer. The work of pouring the molten steel is necessarily in charge of men of a high order of intelligence, capable of determining when a furnace is "ready to pour." The steel ingots when ready are rolled into long bars of much smaller width and thickness, and the workmen are protected as much as possible from the heat by metallic screens over which water is kept trickling.

In the operation of wire drawing considerable lime dust gets into the air, lime being put on the wire to prevent it from rusting. This department is interesting mainly from the point of view of accidents, the most frequent of which are the result of getting the fingers caught between the wire and drum in drawing from the block; but other more serious accidents, such as fracture of the bones of the leg, punctured wounds of the breast and other parts, sometimes occur. These are caused in some cases through inexperience in the work, and in some by carelessness; but in the majority of cases they are not due to lack of ordinary care on the part of the injured, nor to negligence on the part of any other person.

After the wire is hardened by being run into crude oil it is passed through kettles of molten lead inside the tempering furnaces, and is then finished and wound for shipment. From the tempering furnaces dense blue fumes arise, and envelop the men whose work it is to feed and tend them. Occasional cases of lead poisoning occur in this department. In one establishment, one employee of five years' experience shows the characteristic blue line of lead poisoning on the gums; and another, of fourteen years' experience, in the same room, has a history of "wrist-drop" and other evidence of chronic poisoning. Efficient mechanical ventilation is most necessary in this work, but it is not always provided.

In annealing and pickling, hot, very weak sulphuric acid contained in large vats is used. These vats are sometimes covered with hoods, sometimes not.

Sulphate of copper is used for coppering the wire, and is employed in different strengths. One man, who has followed the work of this department in one establishment for twenty years, asserts that he is in good health, but his appearance testifies otherwise; and a greenish line is observable in the gums, where the blue line is seen in cases of chronic lead poisoning.

In the operation of galvanizing, the wire is passed first through commercial sulphuric acid, then into a weak solution of "spent" hydrochloric acid, and finally through molten zinc. The fumes from the hydrochloric acid are abundant and strong.

In making wire cloth and netting and fencing, wire is first rolled on spools and drums to form the warp, and then the weaving is done on heavy looms.

Japanning is done in a suitable tower, the cloth passing from the rolls through a trough of japan, and as it emerges being subjected to the action of a blower; then passing upward through several stories, where it is dried by steam heat, and finally descending on another side to be wound again into rolls.

In one establishment, where 2,500 men are employed, the lavatories are very small and inadequate. In one sink room there is neither hot water nor soap, and the water-closets are dark and dirty in the extreme. In pleasing contrast are the wash rooms and water-closets of a smaller corporation, which employs about 200 men. All are well ventilated, clean and light. The closets are of the best modern construction, and the sinks are provided with running water, both hot and cold.

### Manufacture of Insulated Wire.

In the manufacture of insulated wire, the wire covered with rubber is placed in metallic containers with powdered chalk, which is used to prevent the coils from adhering to each other. The containers are made to revolve by hand power on ball-bearing tables, and as they revolve the wire is unwound and removed, and at the same time the chalk dust is scattered in all directions. The coils of wire are then put into a vulcanizer and exposed to steam heat at 270° F. for five hours or longer, at the expiration of which time they are removed.

The manufacture of insulated cable is conducted by practically the same process. In the one establishment of this sort visited, wherein are employed 250 to 275 persons, the light, ventilation and sanitary appliances are of the best, and the machinery is properly protected.

### Manufacture of Electrical Apparatus.

Under this heading are included electrical switchboards, meters, telephones, registering devices, etc.

The largest of the establishments visited gives employment to 3,000 or more persons, who operate in two sets of very large brick buildings, in which a very large number of processes are carried on. In the great majority of these processes there are no necessarily insanitary conditions.

In the department where castings are cleaned by means of the sand blast, a number of the employees, who wear glasses, masks and canvas shields or aprons to protect themselves from the flying sand, look pale and suffer somewhat from inflammation of the eyelids, due to the very fine particles of sand which fill the air. The tumblers are equipped with blowers, which appear to be very effective in carrying away the dust. In two of the emery polishing rooms, respectively 40 by 25 feet and 150 by 50 feet, although the emery wheels are connected with blowers and hoods, the air is filled with emery dust. Both rooms are also very poorly lighted. In one of the buffing rooms, although most of the dust is carried away through exhaust pipes, some rouge is perceptible in the air. In one room, in which castings are cleaned by means of acids, there are hoods over the tanks, with mechanical ventilation, by means of which the fumes are very adequately removed.

The brass foundry, in which about 65 tons of brass are cast monthly, is exceedingly well ventilated, and is a model building for the purpose.

In the japanning rooms, where metal parts are dipped into or painted with japan, and allowed to drain off before being baked, there is a strong, disagreeable and somewhat irritating smell, due to the japanning solution; and in another room, in which 6 children between the ages of four-

teen and eighteen are engaged in dipping metal parts into lacquer, there is a strong odor as of wood alcohol.

Concerning other features of this establishment little need be said, the conditions throughout being at least fairly commendable.

The establishment second in size gives employment to about 1,000 men and 75 women, in light and thoroughly ventilated buildings, in which all of the conditions may be rated as good. This establishment provides a large, attractive lunch room, which is used by a very large proportion of the employees.

The foundry is very large and open, and is from 50 to 75 feet in height.

The emery polishing rooms are so well equipped with hoods and fans that only a very slight amount of dust is perceptible.

In the japanning department the work is done with the exercise of so much care that little discomfort is occasioned.

The establishment third in extent occupies a number of buildings, in which the light varies from good to poor, and the ventilation is assisted by hoods and exhaust fans. Most of the conditions observed are commendable, and only a small proportion of the 400 employees, and these chiefly young girls and women, appear to be in poor physical condition.

The remaining smaller establishments are well lighted and ventilated; the emery wheels have efficient hoods and blowers, the general conditions are commendable and the employees look healthy.

### Manufacture of Surveyors' Instruments.

In the 2 establishments devoted to the manufacture of surveyors' instruments, in which together somewhat more than 100 persons are employed, the general conditions as to light, ventilation and sanitation were noted as good. In both the acid dipping of brass parts is conducted under good-sized hoods, which are efficient in carrying off the fumes. In both establishments the lacquering is done by women, but the lacquer is made with grain alcohol instead of wood alcohol. There is practically no grinding or polishing by machinery, most of the work being cut with tools or smoothed with a file and emery cloth. Occasionally some parts are polished on cloth wheels, but this is done too infrequently to merit much attention.

### Manufacture of Watches.

In the manufacture of watches, although a very large number of processes are carried on, there appear to be very few which involve any exposure to unhygienic influences that are worthy of much consideration.

The work is mainly very fine work, requiring sharp eyesight and unusual manual dexterity.

In a very large watch-making establishment it was noted that the principal objectionable feature is one which is not inherent to the industry, and far from necessary, namely, overcrowding. For example: one room, 185 by 24 by 10 feet, is occupied by 142 men, women and girls, and by large numbers of machines which take up considerable room; another room, 180 by 24 by 10 feet, is occupied by 132 men, women and girls, under the same conditions. In some of these large rooms it is most important to exclude dust, and therefore free ventilation from the outside is impossible; and, in consequence, the large number of persons present cause the air to be distinctly foul.

All of the rooms in which grinding and polishing machines are operated are very adequately ventilated by exhaust blowers, and no dust is perceptible in the air. In some of the rooms the grinding is done by the wet process.

In one small room, where one man treats dials with nitric acid, nitrous fumes are quite strong. In another, in which enamel is sifted and ground by one man, there is much fine dust, and the occupant wears a sponge over his nose; but the emery dust causes a condition of inflammation of the conjunctivæ. In another small room there is a strong odor of benzine, from the washing of small parts in washing machines containing that substance. In a number of other rooms fumes of benzine are observed to a greater or lesser extent.

In a number of rooms potassium cyanide is used with acid and alcohol in a process of cleaning small parts. This process is conducted under a hood equipped with a blower, and the fumes are effectively removed.

### File Cutting.

In the manufacture of files the workmen are exposed to a double danger, namely, exposure to metallic dusts and contact with metallic lead. The best files are cut by hand, no machine having as yet been invented which can produce their equal. The blanks are first ground smooth with the aid of stones, and in this operation considerable mineral and steel dust is caused. During the process of cutting the file lies on a base of lead, and the lines are cut by a chisel struck by a heavy hammer. The leaden bed offers sufficient resistance, while at the same time it is sufficiently yielding to prevent a sharp recoil. As the file is cut it is constantly brushed off, usually with the hand, which thereby becomes to a certain extent coated with very fine particles of lead, and the air becomes more or less impregnated with lead and steel dust. A common habit of file cutters in manipulating the file is to wet the finger and

thumb with the tongue, thus conveying to the mouth particles of lead, which, through the acts of conscious and involuntary swallowing, gain access to the stomach. The work is very laborious, and the attitude which the workmen are obliged to assume is one which does not admit of normal respiratory movements, since they sit at a bench and stoop over the file.

The workmen of this class are notoriously careless, and are inclined to reject the idea that their calling is not free from danger; but, although in the establishments visited an occasional workman was observed to be pale and sickly in appearance, it must be admitted that as a class they looked well and strong.

Five shops of this class, employing from 5 to 70 persons (150 in all), presented reasonably good hygienic conditions. All showed fairly good ventilation, and but 2 were not well lighted. In 2, employing respectively 8 and 60 workmen, considerable dust was perceptible in the air.

### The Jewelry Industry.

The manufacturing jewelry business in Massachusetts is for the most part centralized in an area which includes the adjoining towns of Attleborough, North Attleborough, Plainville, Norton and Mansfield. In Attleborough it gives employment to between 6,000 and 7,000 persons, in North Attleborough to between 4,000 and 5,000, and in the other towns mentioned to hundreds more. In Attleborough the number of establishments visited was 57; in North Attleborough, 38; in Plainville, 5; in Norton (Chartley), 3; in Mansfield, 2. Outside of this area, the only establishment visited was 1 in Leominster. The great majority of the employees are native born, Irish, and French Canadians, in the order given. Generally speaking, they are a sober, industrious and intelligent class, and a large proportion of them own their homes. Many of them are persons of good education, and their homes show abundant evidence of taste and refinement. In general, their appearance is healthy, and many who have followed the industry for twenty and more years speak of the work as being entirely consistent with good health.

In this industry the processes conducted are necessarily numerous, but for the purpose of this report only a few of the most important need be described.

Whatever the kind of jewelry to be made, the basis is what is known as "flat stock," made by "sweating on" bars of gold, usually of 12 carats, to bars of the same width of brass. The bars, with silver solder interposed, are clamped together and heated in a gas furnace to a cherry-red heat, when they unite. The resulting bar can be rolled to any desired thickness, the gold spreading equally with the brass, so that when down

to .005 the stock assays the same as the bar before rolling. From this "flat stock" both tubing and wire may be made, from which are manufactured chains of all descriptions, bracelets, slides and ornaments of various kinds.

In making such an article as a fob top, which may be taken as a type, a piece of flat stock is struck with a steel die according to the pattern desired, then taken to a press and cut out in a steel cutter. The several parts are next put together and soldered into the desired shape, the plate being coated with boric acid before the application of the solder, in order to oxidize the surface and keep it from turning green. After soldering, the piece is placed in a "pickling" solution, which consists usually of a solution of sulphuric acid of about 20 per cent. strength, but it may be as weak as 5 per cent. This removes all of the boric acid. As the pickle gives off no fumes, even though it is used hot, this work is done with entire safety in the open room.

The piece is next polished with cotton cloth wheels and bristle brushes, the dust being drawn away by means of suction pipes and collected under water, and the gold ultimately recovered. The process, being dustless, is not detrimental to health. The piece is now ready for the coloring solution, which consists of a weak solution of potassium cyanide and gold, kept very hot and commonly uncovered. This gives a slight coating of 24-carat gold, which serves to bring out the depth of color for relief and to give a finished appearance, but has no wearing qualities.

Brass goods are plated by "dipping," but first they must be cleaned with acids. Silver is also treated with acids, to remove fire stains. The acids used include nitric, hydrochloric and sulphuric, chiefly the first two mentioned. In most factories these acids, which work more quickly when heated, are kept in hoods with exhaust ventilation, to prevent the escape of the fumes. Generally this work is in charge of one man, but occasionally two, three or four are employed. After "dipping" in the electro-plating solution no polishing is done, this process being too expensive for brass goods; but lacquers of one kind or another are applied, to prevent tarnishing. Lacquers are used also on silver, but never on rolled plate.

Lacquers are of secret composition, but are said to contain gun cotton, ether, amyl alcohol and other substances, and are very inflammable. The fumes are disagreeable, and, as the work requires heat up to about 100° F., it is not inviting.

The machinery in use in this industry includes power presses, foot presses, stamps, rolling mills, drills, large and small lathes, milling machines, grinding machines, planers, grindstones, emery wheels and polishing wheels.

Employees occasionally, through carelessness, get their fingers caught under the presses and stamps, and their finger tips cut or crushed. The rolling mills and other heavy machinery are operated by men. In some factories young girls work the light foot presses, and it is asserted by not a few that they accomplish more in a day than men, and do it more cheaply. The presses require but little physical exertion, and the foot swings about 8 inches. In the department where these machines are operated there are no fumes and no dust.

*Ventilation and Light.* — The most modern shops have large windows, extending from the tops of the benches upward to transoms of good size, and the light is often so strong in the faces of the employees as to necessitate the use of eyeshades. While only an occasional shop is equipped with mechanical ventilating apparatus, most of them have plenty of windows of average size, which are freely movable for purposes of ventilation. In one of the largest factories the benches are placed at a distance from the windows, and the employees complain of poor light; and in the same establishment the upper windows are fastened so as to be immovable, and the ventilation in winter is reduced to a minimum.

*The Spitting Habit.* — The habit of spitting is confined chiefly to the users of chewing tobacco, for whom in most of the establishments spittoons are provided.

## The Lead Industry.

Lead compounds are manufactured by somewhat different processes in different establishments, and the several factories visited will therefore be considered separately.

In one, where from 15 to 20 men are employed in making white lead, pig lead is melted and cast into "buckles" or rounded perforated sheets about 5 inches in diameter. These are placed in large earthen jars or crucibles, containing acetic acid, which are arranged, in layers alternating with tan bark, in stacks, which are large compartments about 30 by 30 by 40 feet, open at the top under the roof of the building. The stacks are completely filled, and then the material is left for several weeks while the process of corrosion goes on. Considerable heat and carbon dioxide are generated, and the lead is converted to hydrated carbonate.

When corrosion is complete the tan bark is removed, and the layers of crucibles are emptied into small carts. As the contents are dry, crumbly scales and crusts, the process of emptying is accompanied by much dust, against the inhalation of which no precautions are taken by the use of respirators.

The product is taken to the grinding apparatus, where at once it is wet thoroughly and then kept tightly covered. The men who attend

the grinding machines are of a different class from those who empty the stacks, and, since they are not exposed to lead dust, they do not suffer from lead poisoning and are comparatively healthy. Those who empty the stacks do not remain long at work. It is said that this is due in part to the disagreeable nature of the work, in part to the fact that they are largely roving characters who do not care to work more than a few days occasionally, and in part to the fact that they acquire lead poisoning and are obliged to quit. Even those of good intention rarely work more than a month.

After the material is ground, it is conducted in the wet state through pipes to the top floor, where it is discharged to a depth of 6 inches into beds which have an area of about 40 by 6 feet. The lead compound settles, the water is drained off, and the residue is dried by steam heat. When it is sufficiently but not absolutely dry, it is shovelled in the form of large lumps into trucks (in which operation considerable very fine dust is given off), and removed for packing into kegs and other containers or for grinding with linseed oil.

In a near-by abandoned tenement house are rooms set apart for washing, dressing and eating. Here everything is exceedingly dirty. There are two small sinks with running water, and hot water is obtained by heating in a pan on the stove. Because the workmen carry it away, no soap is provided, and the men must for a like reason provide their own towels. In warm weather the men eat their dinner out of doors; in winter, in the dirty room therefor provided.

In another establishment white lead is made by the wet process. Metallic lead is melted and poured from a height of 15 feet into water, the result being granulated lead. This is placed in cylinders and treated with acetic acid, which is kept in motion by constant pumping. The various processes are carried on with no evolution of dust, and the final product is filtered out, washed with water and ground in oil. All of the employees are healthy in appearance, and there is no history of lead poisoning.

In an establishment where red lead is manufactured, pig lead is melted in a series of furnaces over coal fires in a long brick building, with good light and ventilation. The men who attend the furnaces rake the lead at proper intervals with long iron bars, standing back some 20 feet from the furnace doors, thus avoiding fumes and dust. Once a day the furnaces are emptied into iron barrows, and the oxidized product is then transferred to a mill, which shifts and grinds simultaneously. All dust from this mill is forced by a blower-fan through a conduit to a room above, which is provided with cloth partitions. The final product is packed into casks without the creation of much appreciable dust.

All of the 17 men employed are mindful of the dangers incident to

lead working, and have had from six to twenty-five years' experience. All seem well and strong, and none has had any sickness which can be attributed to the nature of the occupation during the period of his employment.

In another factory, where 8 men are employed in two shifts, pig lead, and sometimes white lead of inferior quality, is heated in large furnaces, which from time to time are opened for the purpose of stirring the material with an iron bar. After about twenty-four hours the resulting oxide is drawn off into iron barrows, and during this process the air is filled with fine dust; but the workmen are protected therefrom by caps, canvas jackets and cloths wound about their necks, and all wear respirators.

The material, after treatment with water, is screened and then sent to the grinding room, where it is thoroughly ground with water. The mixture of water and oxide is pumped to the fourth story to a large tank, where it is allowed to settle. The oxide is then separated and carried to the drying room, where it is spread on large, steam-heated tables, from which, when dry, it is scraped and transferred to a mill, in which it is reduced to a powder. It is then sent through canvas tubes to barrels for shipment. During the processes of transfer to the mill and packing into barrels more or less dust escapes into the air, but the persons exposed thereto are protected by respirators. Each man exercises due diligence against the possibility of poisoning, and before leaving the establishment washes carefully and changes all his clothes.

In a lead paint grinding establishment, where 24 men are employed, the dry material is mixed with linseed oil, the workmen avoiding as much as possible the creation of dust. The machines in which the mixing is done discharge through pipes to the grinding machines on the floor below; these require no great attention. The final product is filled into cans and other containers. On the day of visit no dust whatever was perceptible, and none of the employees showed any evidence of poor condition.

In another establishment, where among other materials about two barrels of white lead are used per month, all of the 40 employees appear to be in good health, and the conditions everywhere were found to be commendable.

In another, where various kinds of paints are ground, lead is gradually being supplanted by zinc oxide. When white lead is used, it is shovelled dry into the mixers with oil. No cases of lead poisoning have occurred at this place.

The 18 men and 3 women, the latter engaged in labelling cans and kegs, appear to be in good health.

### Manufacture of Lead Pipe and Plumbers' Supplies, etc.

In the operation of melting lead in hooded furnaces and running it through the proper dies and moulds, lead fumes are given off in abundance; but, in factories in which the health of the workmen is properly safeguarded, these are carried away by hoods and exhaust pipes. In all 5 of the lead-casting establishments visited, in Boston, Holyoke and Westfield, all of which were found to be fairly or well lighted and ventilated, all of the employees appeared to be in good health, and in no instance was it possible to trace a case of lead poisoning to conditions obtaining or processes followed. While it was observed that it is the custom to handle lead with bare hands, the workmen, generally men of experience and intelligence, appeared to observe the necessary precautions as to personal cleanliness against acquiring lead poisoning.

In the largest of the casting rooms visited 54 men and 12 women are employed, and all appear to be in good health.

### Manufacture of Solder.

In making solder, tin and lead dross are mixed with resin and charcoal, and heated in a furnace covered with a hood. After sufficient melting and stirring, the product is drawn off into a small pot furnace, dipped out with ladles and run into moulds. In an experience of thirty-five years but one case of lead poisoning has been known in the small establishment in which this work is conducted, and he was a worker in lead before he came. In this establishment it is noticed by the employees that no rats are ever seen, and the workmen who have attempted to keep dogs or cats have lost them very soon by lead poisoning. The men are very careful to wash thoroughly before going to meals.

### Pottery.

The pottery industry in Massachusetts is one of no great extent, and but 6 establishments were visited; these are situated in East Boston, South Boston, Dorchester, Cambridge, Dedham and Chelsea. The number of persons employed ranges from less than a dozen to somewhat more than 150. The products include all grades, from common flower pots to the highest quality of fancy pottery and crackle ware.

The process which is recognized in the great pottery centers of Europe as the most important from a sanitary standpoint is that which brings the employees into contact with lead, which is one of the principal ingredients of the mixtures used in glazing. These mixtures are of various kinds, and contain variable amounts of lead in several forms, the least harmful of which is known as "fritted." The glazes employed in the

establishments visited contain lead in one form or another, with one exception, and this is a secret mixture. In one establishment, fritted lead alone is used. While lead poisoning is a common condition in the great French and English potteries, it is almost unknown in the 6 home establishments visited. In 1 of them, it is said, there were two cases several years ago among the girls who applied the glaze; but in 3 of them the men who mix the glaze and are more exposed to possible danger than others who handle it have performed the work for from ten to thirty years without injury to their health or to their healthy appearance. It is to be said, however, that the persons engaged in this industry appear to be intelligent and to understand thoroughly the importance of care and strict personal cleanliness; and that the employers provide ample means for its maintenance.

In certain of the processes, considerable dust arises, but these are not continuous, and the persons exposed thereto appear to have suffered no injury.

In all of the 6 establishments, the conditions as to light and ventilation are good, what machinery there is is well guarded, and with two exceptions the toilet arrangements are excellent. In one the closets are unclean, and in one they are filthy.

In each place the general health of the employees is noticeably good.

## Piano Making.

In the manufacture of pianos many (some 30 or more) separate processes are conducted, but very few are attended by any possible danger to health. These include planing, polishing, varnishing and bronzing. In the operation of planing and polishing wood, considerable fine dust may be given off, but in model establishments this is carried away by efficient exhaust ventilation. In polishing and buffing metal parts on emery and buffing wheels, the usual dusts arise; but with mechanical ventilation these, too, are effectively removed. Bronzing is always a dusty process, in spite of all precautions, but the number of men who are engaged therein is not large. Varnishing and fine polishing are conducted in practically dust-proof and consequently not well-ventilated rooms.

Two piano factories, one situated in Cambridge and employing 300 persons, the other in Boston, employing about 500, were visited. Both occupy large, well-lighted and in general well-ventilated buildings. In both, ample provision is made for the removal of dusts of all kinds, and the rooms are practically dust-free, except that in one, where 4 men use emery and buffing wheels, the exhaust draft is somewhat poor and at times there is considerable dust; and in another, in which woodworking is conducted, the hoods and exhaust pipes are only partially effective.

In the varnishing departments, which, as stated, must be kept free from dust, and hence cannot be freely ventilated, there are fumes of wood alcohol, but the number of persons exposed thereto is not great.

In one the bronzing is done by one man, who has worked constantly for twenty years, and states that, although he knows that he has some form of chronic poisoning, he suffers little therefrom. Formerly he wore a respirator, but he abandoned its use because it made a green line on his face. While he is very careful to wash thoroughly every day, he looks pale, has greenish discolored gums, and shows the effects of his calling.

In one there was noticed but little spitting, and in the other none at all. In the latter are posted notices regarding the danger of the spitting habit to health.

In both the rooms are very large, and each employee has an abundance of air space.

### Lithographing.

In the lithographing business there are many processes, but most of them are devoid of danger to health, and only those which are attended by possible danger will be considered. One large establishment devoted to this industry, employing about 700 persons, was visited. The work is conducted in many rooms, mostly large, in a number of large brick and wooden buildings. Almost all of the rooms are low studded, badly lighted and inadequately ventilated.

In the process of etching zinc plates, in which process nitric acid, diluted with about a fourth of its volume of water, is used, nitrous fumes are given off in such amounts as sometimes to be very troublesome, there being no hoods and no artificial ventilation. In winter the workmen not infrequently break the windows, in order to get fresh air.

In the rooms in which prints are made from the zinc plates and the lithograph stones — 2 rooms, 200 by 50 feet, occupied respectively by 75 and 175 men — there are strong odors of turpentine, etc., and the air is very bad, in spite of the fact that the vacuum system of artificial ventilation is employed.

In the operation of bronzing, which is conducted in a room 40 by 35 feet, occupied by 8 men, the sheets are run through a press, which prints the design in sizing, and then they are fed into bronzing machines, from which, in spite of their metallic coverings, the bronze powder escapes freely into the air. The boys who run the 5 machines wear handkerchiefs over the nose and mouth. They look pale and unhealthy, and all show the characteristic green perspiration due to contact with bronze.

In one side of the room is an exhaust ventilating fan connected with a wooden flue. This helps the ventilation considerably, but in spite thereof the air is heavy with bronze dust most of the time.

In the finishing room, 200 by 80 feet, occupied by 135 to 200 employees, mostly women and girls, where the operations of folding, perforating, pasting, cutting and embossing, etc., are carried on, the air and light are rather poor. Mechanical ventilating apparatus has been installed, but has not yet been given a fair trial.

The great majority of the employees appear to be healthy.

### Manufacture of Chemicals.

In the manufacture of chemicals, as carried on in the largest establishments of the State, a great variety of substances are produced, and necessarily a great variety of processes are employed. The chemicals which are associated in the public mind with possible dangers, namely, the corrosive acids, are, as a matter of fact, made in such a way that in the several processes practically no fumes whatever escape, the work being enclosed from beginning to end.

A number of processes which give rise to poisonous and irritating fumes are very commonly conducted in the open air, or in sheds with open sides and ends.

In the largest of the chemical factories visited, about 300 men are employed, and a great variety of chemicals are manufactured. The work is conducted in large, well-lighted, adequately ventilated buildings, in which all belting and shafting are well guarded.

The important processes, carried on on a large scale, occupy separate buildings, and the products are in the main not exposed at all to the air.

The workmen, all of whom are adults, are exposed very little to poisonous or irritating fumes and dust, or to contact with poisonous or irritating substances; but at certain points in the buildings acid fumes in considerable strength are constantly present, but at these points there is good overhead ventilation, and the workmen are rarely obliged to approach very near.

In this establishment very little spitting was observed, and the general appearance of the employees was healthy.

The conditions obtaining in another somewhat smaller establishment, engaged in practically the same line of work, were found to be equally commendable.

In 3 other establishments, manufacturing the same line of goods, but to a much smaller extent, each employing less than 20 men, the conditions as to light, ventilation, absence of fumes and dust were found to be such as to deserve no adverse criticism. In each the workmen appear to be in good health.

Among the products of the above-mentioned factories may be mentioned sulphuric acid, hydrochloric acid, acetic acid, nitric acid, ammonia, sodium sulphide, sodium sulphate, alum, potassium cyanide, ferrous

sulphate, sodium bisulphite, sodium carbonate, sodium bisulphate, ferric chloride, ferric nitrate, stannous chloride, sodium acetate, aluminum chloride, and various salts of tin, arsenic, antimony, zinc, copper, etc.

In addition to the establishments mentioned, the following, devoted to the manufacture of special lines, may be described: —

*Manufacture of Potassium Cyanide.*

*A.* In an isolated wooden building, 40 by 50 by 30 feet, the product is fused in crucibles and cast in moulds. The fumes are carried away by means of a hood connected with a chimney.

*Manufacture of Arsenate of Lead.*

*B.* Establishment employing 5 or 6 men, in a room 50 by 20 by 10 feet, adequately lighted and ventilated, in the manufacture of arsenate of lead from nitrate of lead and arsenate of sodium. The demand for this product is such that it is made only occasionally, and when ordered is filled into small containers for delivery. No objectionable features were observed.

*Manufacture of Lactic Acid.*

*C.* Fifteen men engaged in the manufacture of lactic acid, in a fairly lighted and ventilated building. The machinery is well guarded. The appearance of the men is healthy.

*Distillation of Tar.*

*D.* Establishment employing from 50 to 100 men in the distillation of tar. In this process the crude tar from gas works is treated in large, out-door distilling apparatus. The first distillate is "light oil" or crude naphtha; the next are heavier oils, from which certain disinfectants and stains are derived; and, finally, "dead oil," "heavy oil" or "crude oil." The residue is the product known as roofing tar and paving tar.

The process, being carried on in the open air, is devoid of the usual objectionable features of occupations in which poisonous, irritating or offensive fumes are given off.

In this establishment all of the employees appear to enjoy good health.

*E.* A small establishment, employing 60 men, distilling coal tar. Conditions same as under D.

*Manufacture of Lampblack.*

*F.* Department of factory designated as "E," in which a half-dozen men produce lampblack, by burning heavy oil and drawing the smoke through a series of brick chimneys. The fires are shut off in the morning, and the men draw out the product with wooden scrapers. It is next taken up a screw elevator to a mill, which grinds and sifts it. It is finally packed in barrels or paper bags.

The men object to the use of respirators, and they are covered with soot.

*Manufacture of Bone Black.*

*G.* Establishment employing 20 men. Calcined bone is ground in mills on the lower floors of two fairly large wooden buildings, and the resulting powder is blown by fans through conduits which lead to the floor above. From the conduits the powder is delivered into large cloth bags, from which it is drawn through appropriate openings into barrels.

The air is laden with dust, but the workmen refuse to wear respirators. They look fairly healthy.

*Manufacture of Facing for Foundry Use.*

*H.* Charcoal and graphite of several kinds, known as "Rhode Island lead" (Providence, R. I.), "German lead" (from Austria) and "silver lead" (from Ceylon), are ground, sifted and mixed by machinery; and from each of the machines employed in the several processes large volumes of extremely fine black dust are given off. The materials are sent from room to room and from floor to floor through chutes or "runs," and, as the dust is so fine that, according to the men engaged, it will sift through anything that is not water-tight, the entire building is so permeated with it that a person entering the place becomes covered with it almost immediately. The 7 workmen say that they get accustomed to the dust, and that they are only occasionally troubled by it. They appear to be in fair health, although rather poorly nourished.

*Manufacture of Stove Polish.*

*I.* Establishment employing 27 women and 18 men. Ceylon graphite is crushed and ground by machinery in the basement, and the product is sent to bins in the third story through a wooden conduit. Very fine dust is given off from the machine, and it passes through every crack and crevice, so that the entire atmosphere of the building is heavily dust-laden. From the bins the fine powder is sent down when and where needed, and is mixed with water to form a paste, part of which is packed as such by girls and women into tin boxes, the rest being made into cakes and dried in an oven. The man who is most exposed to the dust has worked about eight years, and, while he dislikes to inhale it, he is not conscious of being injured by constant contact. He states that he cannot wear a respirator with comfort, since it interferes with deep breathing, which the severity of the work calls for.

The workmen are provided with bath tubs and a plentiful supply of hot water. The men appear to enjoy fair health, but the women and girls, who are being gradually supplanted by men, compare somewhat unfavorably.

*Manufacture of Stains and Blackings.*

*J.* About 75 men, employed in well lighted and ventilated, scrupulously clean wooden buildings. The machinery is well guarded. The materials used include naphtha, wood alcohol, grain alcohol, borax, soap, shellac, Venetian red and nigrosine.

"Spirit blacking" is made in a shed with roof ventilation. About 50 gallons of naphtha with black pigments are used daily. Strong naphtha fumes are given off during the hour or two which the work requires each day, but they are rapidly removed.

In another building, 25 by 100 feet, 3 men are employed mixing saponified solutions of gums colored with nigrosine and other coloring agents, and cooking the mixture in large steam kettles, provided with hoods which can be drawn tightly over them, and connected with large exhaust flues. Here shellac is also agitated with wood alcohol. The fumes in this department are troublesome only when the mixture is drawn off into small cans.

### *Shingle Stains.*

Shingle stains are made by mixing "heavy oil" and various pigments. In some places they are made with "light oils." The pigments, such as Prussian blue, chromate of lead, zinc oxide and iron oxide, are first mixed or ground with linseed oil, then with creosote, and finally barrelled.

*K. L.* Two establishments were visited, and in both the men appeared to be careless in the matter of contact with the pigments.

### *Shoe Blacking and Polishes.*

In the manufacture of shoe blackings and polishes a number of ingredients are used, including Brazilian wax, paraffin, shellac, borax, glue, ammonia, nigrosine, turpentine, grain alcohol, soap, etc., the materials used varying, of course, according to the product and to individual formulas. The ingredients are mixed by churning in barrels or by heating in cauldrons or jacketted kettles. The various pastes which are made with the aid of heat are poured into tins or other appropriate receptacles, and their cooling is hastened in some instances by fanning. When turpentine or ammonia is used as one of the constituents, fumes thereof are liberated to some extent, but, so far as appears, not in sufficient volume to cause appreciable injury or discomfort. The liquid preparations while being poured into bottles give off, as a rule, no fumes whatever.

*M. to S.* Seven establishments in Boston, employing from 3 to 15 persons, and 1 in Cambridge, employing 37 men and 150 girls and women, were examined. All were found to be adequately lighted and properly ventilated, and in each instance the washing facilities and water-closets were good, or at least fair. The spitting habit was but little in evidence, and in the largest of the establishments was noticed not at all. In all, and especially in the largest, the general condition as to cleanliness was excellent; and in all the employees presented a healthy appearance.

### *Manufacture of Varnishes, Paints and Colors.*

*T.* Well lighted and ventilated establishment, employing 13 men. The materials used include alum, sal soda, Prussian blue, anilin, white lead, ultramarine, Paris green, ferrous sulphate, barium chloride, potassium ferro-

cyanide, tartaric acid, etc. The products are oil paints, varnishes, dry colors and coloring pastes. A considerable portion of the work is done out of doors. The men engaged have worked for from six to twenty years. The man who makes the lead colors has worked seventeen years without sickness. The last cases of poisoning at this establishment occurred sixteen years ago, when a number of inexperienced men were poisoned with Paris green.

The machinery is well guarded.

*U. V.* In the larger of the two varnish factories examined 80 people are employed. The light, ventilation and toilet arrangements are all commendable. The machinery is well guarded. A chemical black varnish is made in large kettles, which contain automatic agitators. Among the ingredients is naphtha. After several hours' cooking and agitation, the varnish is drawn off and placed in storage.

In the smaller of the two, 7 men are employed. The ventilation and light are fair. There is but little machinery. The materials used include gums and oils. These are cooked in large kettles over coal fires, and the contents when cooled are pumped through pipes to settling tanks, where they remain in storage several weeks. Each of the kettles is enclosed in a brick compartment, through which the fumes are conducted to the chimney. Occasionally a kettle catches fire, but no harm results, because of the brick enclosure.

### *Colors and Mordants.*

*W.* Establishment employing 27 men, the majority of whom appear to be in good health, but inflamed conjunctivæ were observed to be not uncommon. About one in five of the employees is noticeably pale and sallow. The materials used are anilin colors, logwood, starch, sodium dichromate, etc. It is to the sodium dichromate that the inflammatory condition referred to is due. Considerable starch dust was observed in the air.

### *Manufacture of Whiting.*

In the manufacture of whiting, chalk rock, imported from England, is first dried, or treated with water and then dried, and next ground to powder in crushing machines, which give off much fine powder to the air. The operations of sifting and packing are naturally even more dusty than the process of grinding.

*X. Y. Z.* Three establishments were visited. In all 3, the workmen, 58 in all, have ample cubic space in fairly well-lighted rooms, the air of which on the day of visit was filled with fine dust. The workmen were covered with dust, and, independent of the unnatural white appearance caused thereby, about half looked to be in poor condition.

The habit of promiscuous spitting was observed to be fairly general.

### *Manufacture of Bluing.*

*AA.* In the single bluing factory visited 20 persons are employed. The materials used are prussiate of potash, ferrous sulphate and nitric acid. The

first dry product is ground in a mill, which is well boxed in, and but little dust escapes. The powder is marketed in part as such, and in part in solution in water. The boxing and bottling are done by men and women in rooms of good size, which are light, clean and adequately ventilated. All of the employees appear to enjoy fair or good health.

### *Manufacture of Viscoloid.*

*BB.* Viscoloid is very much the same thing as celluloid, and its manufacture can justly be regarded as a dangerous operation, since one of the processes involved is the manufacture of gun cotton, which is the essential component. In the only establishment devoted to this industry, this substance is made in a large, light room, 72 by 30 feet, in which is a large hood with artificial ventilation for the removal of the fumes of the acids employed. The gun cotton produced is mixed with wood alcohol and camphor in a large room, which is properly ventilated. The stock is seasoned in a separate building, in which a temperature of 98° F. is maintained.

The factory is kept scrupulously clean, and is well provided with sprinklers, extinguishers and water pails, for use in case of fire. Spitting is prohibited, as is also the bringing in of matches.

### Bleaching and Dyeing.

Cotton cloth, as it comes from the mills, is unbaled and sewed together into long strips, which are wound on rolls by machinery. In this process considerable fine lint dust ("flue," "fly") is given off. The strips pass through the "gray room," where they are exposed to the action of non-luminous gas flames, which singe off the lint. Next the cloth is passed successively through a boiling, weak solution of caustic soda or lime, a boiling solution of sodium carbonate (washing soda), a mixture of water and bleaching powder ("chloride of lime," "chlorinated lime"), and lastly dilute sulphuric acid, and then is washed thoroughly with water, dried between steam-heated rollers, stretched, starched, calendered and folded by machinery.

In all 5 bleacheries visited, employing from 60 to 475 persons (about 1,200 in all), the light, ventilation, general cleanliness and toilet rooms are at least fair, and mostly good. The machinery was found to be adequately guarded, and in each establishment the steam arising in the processes of washing and drying is removed more or less thoroughly by means of exhaust blowers. In one instance, however, in spite of the action of six large exhaust fans, the amount of condensed steam present in the air at the time of visit (a stormy day) was such that one could see not more than three to six feet in any direction.

In one of the establishments the persons exposed to the lint dust which escapes during unbaling and stitching together looked pale and sickly,

but with this exception the employees presented generally a healthy appearance.

The odors of bleaching powder, although observable in each of the rooms where that substance is employed, were in no case so strong as to be disagreeable or to cause discomfort.

In the dyeing and printing departments the employees are subjected to the influence of no objectionable substances, the colors of whatever nature coming but very little into direct contact with the operatives. The mixing of colors is done by a very small number of men, and such as require heat are treated in steam-jacketted kettles connected with exhaust flues. There is some disagreeable odor connected with the mixing and application of colors, but, like most merely offensive, not irritating, smells, it appears not to interfere with health.

### Dyeing and Cleansing.

In a large dyeing and cleansing establishment, situated in the town of Watertown, a very wide variety of processes are conducted and many different chemical substances are employed. The latter include naphtha, gasolene, wood alcohol, ammonia; various acids, including acetic, oxalic, sulphuric and hydrochloric; bleaching agents, including chlorinated lime, hydrogen peroxide and sodium bisulphite; iron salts, including nitrate, acetate and sulphate; copper sulphate, borax, alum, sodium carbonate and sulphate, potassium permanganate and cyanide, caustic potash, soap, anilin dyes and other dyestuffs.

The buildings comprise a large new brick and cement fire-proof structure, a less modern brick and wooden building, and a wooden laundry. These are light and well ventilated, and are provided with modern toilet conveniences in fair to good condition.

All goods are received in a checking room, 60 by 40 feet, in which 10 to 15 women and girls mark and check each piece. From this room the pieces are distributed to the several departments. In what is known as the "spot room," which is 120 by 25 feet, 10 men and 3 girls remove spots by means of naphtha, wood alcohol, ammonia and other agents, which are applied with pieces of cloth. The ventilation here is distinctly good.

In a large wash room, 65 by 30 feet, 10 or 12 men are employed washing goods in large tanks and vats. This has a brick floor, which drains well and quickly, and it is equipped with a 28-inch fan to assist the ventilation. The room is clean, and free from vapors.

The room in which 5 to 10 women do small repairing is somewhat overcrowded, but it is clean, light and well ventilated.

The folding room, glove room and shipping rooms are open to no

objections. The drying room, in which goods are hung for several hours after cleansing or washing, is kept at a temperature of somewhat higher than 100° F., but nobody works here for any length of time.

From 50 to 75 persons are employed in the several pressing rooms, the lace room and the curtain room, which are commodious, light and well ventilated. In the pressing rooms gasolene gas is used for heating the irons, and this causes more or less odor of vaporized gasolene, especially in cold weather, when the windows are closed, and this is exceedingly irritating to the eyes and respiratory passages when sufficiently strong. The occupants of these rooms, however, appear to be in good health.

In the naphtha-cleansing department, occupied by 6 to 8 men, are a number of washing machines, filled with naphtha and ammonia, in which clothing, gloves, etc., are cleansed. The means for fire-protection are ample and adequate, and there is also installed a system of mechanical ventilation which does much to reduce the amount of naphtha and ammonia fumes in the air. In spite of all precautions, however, there is a strong odor of naphtha, and all of the men here employed are pale and some of them very markedly sick looking.

In the room in which the naphtha-cleansed goods are dried, at a temperature of about 120° F., the naphtha fumes are very strong. Although the men who bring in the goods remain but a few minutes, some have occasionally been temporarily overcome by the fumes, and have shown the characteristic excitement and hysterical symptoms of naphtha intoxication. At the time of visit, the man who does most of this work had been engaged thereat for three months, and had experienced no ill effects.

The dyeing department is clean, light and well ventilated. The sloping floor is of brick, and drains rapidly to the sewer. The 10 occupants appear to suffer no discomfort.

In the rug and carpet cleaning department there is a large enclosed dusting machine, which is equipped with a fan and dust flues, through which the lighter dust is carried away. The heavy dust and dirt fall to the bottom, and are removed at short intervals after being covered with chlorinated lime. The work here is attended by considerable dust, but the several workmen show no ill effects therefrom.

## The Rubber Industry.

In the 14 rubber factories visited in the course of this investigation, of which number 5 are very small, employing less than 50 persons each, about 9,000 persons, mainly below forty years of age, and about evenly divided as to sex, are given employment. In these establishments are manufactured rubber boots and shoes, rubber cloth and clothing, cotton and rubber goods, "electric" tape, rubber heels and other hard

and soft rubber articles; but the majority of the persons employed are engaged in the manufacture of boots and shoes, and no fewer than from 2,600 to 3,100 work in a single factory, situated in Watertown, which is the largest of its kind in the world.

Following are the processes followed in the manufacture of rubber footwear and cloth: —

*Treatment of Crude Rubber.* — The large cakes of crude rubber are broken up by a "cracker" machine, consisting of two large revolving steel cylinders, from which the product falls into pans or trays. It goes then to a machine known as a "washer" or "sheeter," where it is run between revolving cylinders, upon which a continuous spray of clean water is maintained. After being rolled into rough sheets, it is put into a tank, from which it is taken to the "beater" machine, in which water runs continuously, and then it is washed again and "sheeted out."

*Calendering.* — The sheets of rubber after being dried are taken to the "compound" room, where they are sprinkled with whiting, to prevent sticking, and weighed. Next they are taken into the calender room to a "mixer," by which the rubber is mixed with other substances, which include sulphur, litharge, whiting, lampblack, tar, resin, lime, palm oil and linseed oil. The next machine is known as a "refiner."

The rubber in the state in which it exists at this stage of manufacture goes to the calenders in company with cotton cloth, jersey, duck or other kinds of cloth, which has been heated by means of a cloth-drying machine. One of these large calenders has four great cylinders, one over another. The rubber passes between the two upper, and the cloth between the two lower rolls. The former emerges spread so thin that the thickness of the sheet cannot be gauged, and both come off together and are run into the cotton room. Similarly, the rubber as it comes off the calender rollers in long, thin sheets is run on a specially designed frame for bootleg covers and upper stock.

*Cutting Uppers, Heels and Soles.* — Heels are cut out of thick rubber by means of dies struck by heavy iron mallets. Uppers and soles are cut out partly by machine and partly by hand. The hand work requires great skill and deftness, and is performed by men. Boys cut small pieces used for reinforcing, and they roll out bootlegs and do other light work.

*Cutting Linings.* — Different kinds of cloth are used for linings. Whatever the kind, it is coated thinly with a cement of rubber dissolved in naphtha. After this is done it is wound into rolls. A roll is set up at the end of a long counter in such a way as to permit it to be unwound as desired. Thus a layer of rubber-coated cloth is drawn over the whole length of a very long, wide table (the cloth generally runs 54 inches

wide); a layer of paper is then unwound over the rubber cloth, so that paper and cloth alternate until the desired number of layers is obtained. Generally, linings for nine pairs of shoes are cut at once. The linings are cut both by hand and by machine. Men who cut with dies, by hand, stand at the bench and use iron mallets like those used in cutting heels. Innersoles, heel pieces and linings are all cut by means of dies in the same manner.

*Quartering and Cementing.* — The edges of the several parts are spread with cement, and then the parts are taken to the making room and distributed.

*Making.* — In the making department the boots and shoes are put together. Women make the light overshoes, men make the heavy ones. Rubbers are made by women, but men put on the outer soles.

Linings are first applied smoothly to a wooden last and cemented together, the cement side out. The rubber parts are then stuck on and rolled firmly with a small hand roller. Young women become very skilled in this work, taking up the several parts in rapid succession, placing them accurately upon the last, and rolling and pounding them firmly together.

Perhaps the most interesting single process is that of putting the rubber boot together. This work is done by men, and requires, in addition to accurate eyesight, rapid and very deft movements of the hands and considerable strength.

Varnishing. — The goods which require varnishing are placed on racks and treated with a mixture of boiled linseed oil, naphtha and other materials, which is applied with brushes, and imparts a gloss to the surface.

*Vulcanizing.* — The shoes or boots, placed on trucks, are sent into "heaters," where they are subjected to a temperature of 280° F. or higher, whereby the strength and elasticity of the rubber are increased.

*Rubber Cloth Making.* — The crude rubber is put through the washing process, dried and mixed with sulphur, litharge, coloring matter, etc., and then is taken to the cement room, where it is "cut" with naphtha, forming a thick paste or dough. This is taken to the spreading room in large tubs and fed into the roller machine, which is like a long table made of steam pipes placed horizontally in a single layer. Below one end is a roll of cloth, which is passed between two iron rollers on the end. The dough is fed in between these rollers and is spread smoothly over the cloth, which is rolled up and removed to a heating room, where it is unrolled and hung on racks, and then subjected to sufficient heat to cause combination of the sulphur and rubber (vulcanization).

"Electric" tape is merely strips of cloth spread with rubber cement.

Rubber heels are made in large part in the following manner. Rubber

is ground finely in a mill, mixed with other gums, etc., and made into a paste with naphtha. The mixture is put into moulds and vulcanized in the usual way.

In former times the vulcanizing agent used was carbon disulphide, fumes of which are well known to be harmful in their effects upon the nervous system. Now it is used but seldom, and then only in small quantities and for special purposes.

In 11 of the 13 rubber factories visited, situated in Blackstone, Boston, Brockton, Cambridge, Chelsea, Malden, Melrose, Reading, Stoughton and Watertown, the odor of naphtha was noted as only slight, even in rooms in which that substance is extensively used; namely, quartering (where parts are cut out and edges are cemented), making (where the parts are assembled) and cement (where the cement is made). In 2 factories it was stated that some girls, new to the work, show the effects of naphtha, and suffer from headache and sometimes nausea and vomiting, but that such girls do not long continue at the work. Naphtha fumes sometimes bring about a condition which much resembles alcoholic intoxication, and which occurs most often in the room where rubber is spread upon cloth. New men are especially susceptible, but even old hands have sometimes to leave their work at times for a breath of fresh air.

All of the establishments were found to be well lighted and adequately ventilated with one exception; and in this place the general conditions are far from satisfactory, there being, in addition to poor light and bad air, general uncleanliness and considerable dust.

In 6 factories, in which white lead or lead monoxide (litharge) is handled, no history could be obtained of any cases of lead poisoning, even among those who do the mixing. In 2 it was stated that cases occur, but not often. In 1 no lead compound is used; this is one of the smallest factories. The reason for employing lead is that its association with sulphur seems essential to the success of the latter as the vulcanizing agent.

In but two instances was machinery found to be inadequately guarded; in one the large gears of the calenders and in the other some right-angled gears on spreaders were unprotected.

In no factory were the toilet accommodations in distinctly bad condition.

### Manufacture of Straw Hats.

In the manufacture of straw hats are several processes which involve possible exposure of the workmen to unhygienic conditions. Among these are bleaching, varnishing, sizing, staining and blocking.

The bleaching of the straw is done with sulphur fumes. The sulphur

is ignited in a kettle in a closed room, and to the resulting fumes the stock is exposed. Naturally, the employees are exposed to these fumes only when the doors are opened for the removal of the stock, but they do not enter until the fumes have escaped or have been driven out. In another process of bleaching the stock is immersed in a bath of water, bisulphate of sodium, zinc dust and hydrochloric acid. Other chemical agents are oxalic acid, tartaric acid, acetic acid, sodium peroxide and hydrogen peroxide. The braid is left in the bath for a certain number of hours, and is then taken away and put into the drying-room. The workmen engaged in this process do not wear respirators, and those who were interviewed state that neither process causes anything more than a temporary irritation of the throat, and that many of them have worked in this department for many years.

The varnish used on straw hats is made of shellac cut with wood alcohol, and is applied to the straw braid with a brush. The fumes given off cause in some of the operatives a burning sensation in the eyes.

For stains, solutions of anilin dyes in wood alcohol are commonly used. Some hats are brushed over with a mixture of benzoin, camphor, anilin black and wood alcohol; some are covered with white shellac cut in wood alcohol; and, as in the varnishing processes, those who do this work are exposed to wood alcohol fumes. In the process of sizing with glue a high temperature is said to be necessary, in order that the glue may run off freely; this temperature is commonly about 100° F.

The largest of the 3 straw hat factories visited employs about 200 persons, mainly from twenty-five to thirty years of age. The buildings are in part poorly lighted, in part well lighted. Ventilation is adequate, and is provided by windows, air shafts and openings in the roof. In certain of the rooms ventilating fans are used. In the rooms in which wood alcohol is used the fumes were observed to be fairly strong.

The second largest of the 3 factories employs from 100 to 225 persons, according to the season. The buildings occupied are clean, well lighted and thoroughly ventilated. Very few manufacturing plants of any kind visited show such good conditions as to cleanliness, light, ventilation, toilet and wash rooms. The ceilings are high, and the walls and ceilings are whitewashed.

The drinking water is brought in from the outside, since the water with which the factory is supplied for general purposes is polluted and unfit to drink. The water taps bear, however, no warning notice concerning the character of the water, and the vessels containing the water from the outside are neither sufficiently numerous nor sufficiently accessible.

### Glue Making.

In the manufacture of glue, the materials, chiefly "fleshings" and hide scraps, are first washed in water, then placed in tanks with lime and water, in which they are left for several days, during which time the hair is loosened and detached. After removal from the tanks they are stored until wanted, when they are washed as free as possible from lime, and then placed in tubs and exposed to the action of steam. From time to time the liquor is drawn off from below and set away in pans to solidify to a hard jelly, which is cut into slices, and then transferred to screens and thoroughly dried. The dried product is then broken up and packed in barrels. Sometimes it is ground to powder in a mill, which creates some dust, which is harmless in effect if inhaled. The residue in the tubs is subjected to further treatment for grease, which is disposed of to tanners. The hair is dried by steam heat, and baled for use. It is employed chiefly in plaster. In handling the hair much dust arises, and to protect themselves from its inhalation the men commonly wear handkerchiefs over their noses and mouths.

Gelatine is produced in the same manner as glue, but from a superior grade of stock.

Fish glue is made from the by-products of the fish-preserving industry, which are treated in large steam tanks. The liquor is drawn off, filtered and evaporated to the required consistency and bottled for shipment.

The manufacture of glue and gelatine is necessarily an offensive occupation, owing to the nature of the materials used; but experience has shown that it cannot be regarded as dangerous to health. In the 4 establishments visited, in Peabody, Stoneham, Woburn and Gloucester, in which from 25 to 200 persons are employed, the sanitary conditions were found to be beyond criticism excepting in one, where the privies were indescribably filthy. In every instance the appearance of the employees as to health was most excellent.

### Tanning.

Most of the processes of tanning are very laborious, some of them are very wet, and all of them are to a greater or lesser extent offensive. The leather industry is one, therefore, that calls for strength and endurance.

To a considerable extent the so-called chemical process has supplanted the old tan-bark and sumac methods, but in some establishments both processes are carried on with different kinds of skins.

In the old-fashioned process the bark is ground coarsely, and the resulting "tan" is treated in vats with hot water, into which live steam

is turned. The liquor so obtained is employed in various strengths as needed. In the newer method the tan liquor is displaced by a solution of potassium dichromate, which produces its results with much less expenditure of time.

Whichever process is followed, the preliminary work is the same. The hides are soaked first in water and then in water to which lime is added, and then they are removed from the vats for further treatment, which includes washing and removal of hair and a number of other processes, all of which involve exposure to wet, and are disagreeable, the odor of a "beam house" being commonly noticeable at considerable distances.

All of these processes demand the services of men of good physical strength. When the hides or skins are ready for the tanning process, which, whether "old-fashioned" or "chemical," is essentially and necessarily one of chemical change, they are placed either in a vat of bark liquor, in which they remain for a number of days or weeks, or they are put into a revolving drum, known as a "pin-wheel," or into a pit in which are revolving paddles, with a dilute solution of potassium dichromate or sodium dichromate, acidified with hydrochloric or sulphuric acid, and caused to revolve or to be overturned for seven hours or longer; after which time, if the pin-wheel is employed, the liquor is drawn off and replaced by an acidified solution of sodium thiosulphate or bisulphite, and then the revolution is continued several hours longer; and, if the pit is used, the skins are removed to another, containing the second solution, and kept at rest or overturned for a like period.

In removing the skins from the pin-wheel or vat and in handling them after treatment with lime for the loosening of the hair, the hands and arms of the workmen are seriously injured, becoming raw if not protected by rubber gloves; but even with gloves it is difficult to prevent injury, and in some establishments the workmen are relieved by the substitution of a single-bath process, in which the liquor, present on its completion, exerts less effect upon the skin.

The later processes of leather manufacture are less laborious, although the work is heavy, and they involve far less exposure to dampness, but more to mechanical injury. In general, however, the unprotected parts of leather-making machinery need not be approached closely by the operatives. In the various processes of drying, stretching, stuffing, hand-whitening, blacking and polishing there are no features which are intrinsically dangerous to health in any way; but the process of buffing on wheels or revolving drums covered with sandpaper gives rise to considerable dust, which, even when exhaust fans are installed for its removal, escapes in most instances to a greater or lesser extent into the air of the

room. In one of the establishments visited, for example, where every part was found to be kept scrupulously clean and neat, and where the beam house, ordinarily a most offensive place, was conspicuously clean and free from objectionable odors, the air of the buffing room was filled with fine dust.

In the manufacture of "patent" leather, which is largely a secret process, the workmen are exposed to fumes which, while far less disagreeable than the odors of the tanyard, are intrinsically dangerous. Thus, in one method employed, the leather receives first a coating of a mixture which contains, among other ingredients, amyl acetate, naphtha and wood alcohol, strong fumes of which substances are given off and are perceptible at considerable distances away. In one establishment, where, on account of ignorance, on the part of the examiner, of the Polish, Greek, Armenian and Syrian languages, and, on the part of the employees, of English, it was impossible to acquire information as to the possible effects of the combined fumes, it was admitted by those in authority that many employees cannot do the work on account of inability to withstand their influences. The basis of the material is linseed oil, which is mixed with the other ingredients in a revolving drum; the mixture is next heated in iron kettles connected with an exhaust flue. The final coating, which is applied with a brush, is a naphtha preparation resembling japanning material. The hide, stretched on a frame and treated, is transferred to a drying chamber, where it is exposed to a temperature of not much more than 100° F. The odor given off in this stage of manufacture is far less offensive than the fumes arising during the preceding process.

Eight tanning establishments, employing from 28 men, in one instance, to 1,100 in another, and about 2,300 in all, showed conditions which in the least pretentious were at least fairly commendable, and in the most approved were as praiseworthy as those met with in cleaner occupations. The business is one in which overcrowding is hardly possible and free ventilation most desirable; and, as is to be expected in a non-dusty trade, requiring strength and endurance, the employees are healthy appearing and well nourished. The only objectionable conditions noted were the dusty atmosphere incident to buffing, and exposure to fumes of naphtha, amyl acetate and wood alcohol.

## Soap Making.

Soap making is properly classed as an offensive trade, since the nature of most of the materials used is such that in the most essential processes of manufacture foul odors are evolved to such an extent that the immediate neighborhood of an establishment engaged in the business is un-

suited to residential purposes. The odors, while disagreeable in the extreme to those unaccustomed thereto, as an incident to their daily employment do not conduce to disease, and it is well known that the employees, as a rule, enjoy good health.

Of the 10 soap factories visited, one of which employs more than 150 persons, about half of whom are girls of about eighteen years of age, all showed general conditions as to light, ventilation and cleanliness which may be classed as fair, and several, considering the nature of the occupation, as distinctly good. In not one did the employees as a class appear otherwise than in good health.

### Rendering and Fertilizer Making.

The rendering and fertilizer-making establishments are, as a rule, situated as far as possible from human habitations, on account of the nauseous odors which are inevitable concomitants of the business. In ordinary rendering the materials used are fat, meat trimmings, bones, etc., the products are oils, grease and "tankage," and the processes employed are so conducted as to reduce as much as possible the amount of offensive odors which escape into the air and render the immediate vicinity undesirable for residential purposes. The fumes given off are in no sense dangerous to health, although highly disagreeable; and, except in certain processes of handling dried tankage, there is no great exposure of the workmen to dust, — what dust there is, is, moreover, of the most harmless kind.

In all of the dozen rendering plants examined the general conditions as to cleanliness of rooms, light and ventilation were found to be at least fair, and in some instances excellent. The workmen presented, in general, the appearance of rugged health.

In the two largest fertilizer works visited, one in Weymouth, the other in Billerica, which employ respectively about 275 and 100 men, the materials from which the final product is made (tankage, garbage, slaughter-house refuse, bones, etc.), are boiled with dilute sulphuric acid in tanks properly covered and provided with flues which convey the fumes to condensers. In the process of dumping into the tanks some of the men wear cloths over the mouth and nose, but others do not. The product of the tanks is drawn off as a thick mass, which dries in a day or two to such an extent as to permit breaking up and grinding. In the operations of grinding and packing there is escape of more or less dust and fumes, but the men engaged therein appear to suffer no inconvenience, and some of them have been engaged at the work for long periods.

In one of these establishments the sulphuric acid used is manufactured

on the premises in the usual manner, without exposure of the employees to any danger to health.

In both the general health of the workmen appeared to be good; but in one a certain proportion, mostly men of no fixed habits of work, engaged only temporarily and therefore not accustomed to the nauseous odors, looked pale and poorly nourished.

### Slaughtering and Packing.

Although Massachusetts is by no means prominent as a center of the slaughtering and packing industry, the annual value of her few large and many small establishments of this class is, according to the census of 1900, more than $30,000,000, or $8,000,000 greater than that of her paper industry, in which she leads the country, and $4,000,000 more than that of her leather industry, in which she stands second only to Pennsylvania.

All of the larger and 201 of the smaller slaughtering establishments have been examined; and, owing to the popular interest in and distrust of packing-house conditions and methods, caused by reports concerning certain of the very large establishments of Chicago, the results of the inquiry were published in the "Monthly Bulletin" of the Board. Inasmuch as the names of those whose conditions were found to be commendable have already once been made public, there seems to be no reason for suppressing them in this report, and they are therefore reproduced.

In the larger establishments but few conditions were found which merited criticism; but the great majority of small slaughterhouses, situated chiefly in the country districts, were found to be far from commendable, and many of them worthy of the severest condemnation. Of this class, 201 were visited, but it is not known how many exist. The authorities of 101 cities and towns reported that no slaughterhouses are maintained within their borders; those of 103 failed to reply to the Board's circular letter requesting information on this point, but 24 of these places were visited, and slaughterhouses were found in all but 7. Of the remaining places, 45, which, through lack of sufficient inspecting force, could not be visited, reported a total of 114. Thus there are known to be 315 small slaughterhouses, with 79 towns not heard from. Of the 201 examined, only 74 were found to be conducted under commendable conditions.

Following are the results of the examination of the larger establishments, situated in Boston, Cambridge, Chicopee (Brightwood), Somerville and Worcester: —

*North Packing and Provision Company, Somerville.* — *Pork Packing.*

This is a large establishment, with a number of separate departments, described below.

*Hog House.* — This has an area of 5,921 square feet, and is eight stories high. Each floor is laid with bricks, and is divided into pens about 40 by 50 feet in area.

The hogs are driven up inclines from floor to floor as soon as they arrive at the establishment. If they are not to be killed at once, they are given a feed of corn and are watered; but forty-eight hours is the longest interval between arrival and slaughter.

The place is washed down every day with a hose. The floors drain into the sewer. The condition is most satisfactory.

*Killing Room.* — This has an area of nearly 12,000 square feet, and is fairly lighted and properly ventilated. From the killing pit the hogs are dropped through a chute into a vat of hot water. When the carcasses have been scraped and dressed they are hung up to cool. As the slaughtered animals pass along they are examined by two government inspectors, stationed about 75 feet apart. One looks and feels for glands, etc., in the neck; the other looks at the viscera. Condemned carcasses are split with an axe and are sent to the rendering tanks.

As the animals are dressed the offal is sent by chutes to the floor below.

The floor of the killing room is constantly in process of cleaning, and is scrubbed thoroughly every night.

*Hog Coolers.* — The hogs are chilled in two rooms, each of about 10,000 square feet area, divided into compartments. The carcasses remain here about forty-eight hours. The floors are covered with sawdust and are cleaned frequently. As these rooms are kept at a low temperature, ventilation is not attempted, nor is it needed.

*Cutting and Trimming Room.* — This department has a total area of about 10,000 square feet. Here the carcasses are cut on benches, each workman having his own part to perform. The floors and benches are scrubbed and scraped daily. Since warm air would tend to promote spoiling, direct ventilation is not employed in warm weather.

*Sausage Manufacturing.* — This department covers almost 19,000 square feet. The lighting and ventilation are excellent. The materials used are pork trimmings and "barrel beef," which is bought outside. The meats are cut into small pieces and fed into grinders, from which the product falls into wooden tubs. After thorough mixing by machinery it goes to the stuffing machine, in which it is forced into casings. The sausages known as frankfurters and bolognas are next boiled and smoked, and finally are washed and cooled.

All machinery is cleaned thoroughly after use, and the floors and tables are scrubbed daily. A man leaving the room is not permitted to return to his work until he has washed at the basin in the corner of the room, and the foremen are held accountable for infractions of this rule.

*Preparation of Sausage Casings.* — In a room of about 3,750 square feet floor space, well lighted and ventilated, 20 men are employed preparing intestines for sausage casings. The intestines are washed and passed through a machine which presses out all contents, and so works that practically nothing but the muscular portion is left. After being tested for perforations and washed, the casings are packed in dry salt.

The room in which this work is carried on has a wooden floor, which, though wet, is kept in properly clean condition. Owing to the nature of the material, there is some unavoidable odor.

*Curing Cellars.* — In three cellars, having a combined area of nearly 56,000 square feet, 30 men are engaged in curing hams and bacon. These are treated in large vats of concrete built up from the floor, each of which has a removable wooden floor laid in sections, which can be taken up and cleaned from time to time.

The temperature of the cellars is maintained at about 35° F., and the air is saturated with moisture. These conditions are said to be necessary in the curing process.

*Soaking and Washing Hams.* — In an artificially (poorly) lighted, well-ventilated room of 4,000 square feet, 40 persons are engaged in washing and scrubbing hams after they have been taken from the pickle and soaked in tanks of water. Here, also, boxes, crates and barrels are washed and scrubbed. The floor is of cement, covered with boards, and is very wet.

*Offal and Rendering Department.* — This department occupies four floors, with a total area of more than 47,000 square feet. The light is fair; the ventilation is mechanical and adequate.

The offal comes through galvanized-iron tubes from the killing rooms. The tongues and other useful organs are trimmed and put aside. The intestines are stripped from the mesentery, and some of them, after being split and washed, are sent to the rendering tanks together with other parts which yield fat. The tanks contain water which is heated until all the fat from the meat, scraps, etc., rises to the top, from which it is drawn off through a pipe. The tank residue is removed and pressed, and then disposed of for making fertilizer. The bones, after removal from the tanks, are dried and used in various ways.

The iron chutes are scoured with washing soda and hot water every night. The floor and tables are washed and scraped, and the whole place is kept in good order. There is practical freedom from flies.

*Beef Salting.* — In the basement of the cold-storage building, in a room of nearly 18,000 square feet of floor space, rather poorly lighted and inadequately ventilated, 7 persons are engaged in salting "plates" and briskets obtained from the large beef concerns in Boston. These parts, for which in the fresh state there is small demand at retail, are trimmed, cut into pieces of suitable size and placed in barrels of brine, to which a small amount of saltpeter is added.

The floor is of wood over cement, and is clean. The room is cold and damp.

*Preparation of Pigs' Feet.* — Pigs' feet are cleaned, scraped and pickled

by 12 men, whose work is carried on in a properly ventilated and adequately lighted room of about 7,000 square feet of floor space.

*Night Work.* — The whole plant is cleaned every night by a force of 60 to 70 men, who start at the killing room, which already has been cleaned and washed by the day men before leaving at night. All machinery, tables and floors are scrubbed with hot water, soap powder and scrubbing brushes. The scalding vat is cleaned thoroughly, as is the entire department in all particulars. Next the cutting and trimming rooms, the rendering plant and all other departments are attacked, and the whole establishment is finished by 6 o'clock in the morning.

The employees number about 1,100, and include representatives of many nationalities. All who were seen appeared to be in fair or good health.

About 90 per cent. eat their noonday meal at home; the others eat about the buildings or in a lunch room provided for the purpose.

Very little spitting was observed anywhere about the plant.

*J. P. Squire Company, East Cambridge. — Pork Packing.*

This establishment is housed in a number of buildings of brick or wood, in fair condition and fairly well ventilated and lighted. The employees number about 800, of various nationalities, all apparently in good health. Very little spitting was observed. More than half go home to dinner; the rest eat in a restaurant provided by the company, or in the yard or work-rooms. The restaurant is clean, and the food is of good quality and served at low prices. Those who prefer to bring their own food may eat it in the restaurant if they so desire.

While adequate provision is made for comfortable eating, the accommodations for hanging street clothes and for washing are somewhat meagre.

The establishment is divided into a number of departments, as follows: —

*Hog House.* — This building covers more than 25,000 square feet, and contains three stories, each of which is divided into pens, in which are troughs of water. The light is good, the ventilation free, the sides being open. After each lot of swine is disposed of the floors are thoroughly cleaned.

No slaughtering is done at this plant. The hogs are driven over a bridge to the killing rooms of the North Packing and Provision Company, and are returned over another bridge to the cooling rooms, which occupy three floors of a building having an area of 64,000 square feet (400 by 160 feet). These rooms are lighted by electricity, and are kept at a low temperature. The floors are scraped whenever necessary for the removal of the slight amount of blood which drips from the carcasses.

*Cutting Room.* — The cutting operations are performed by about 75 men, on a floor space of about 30,000 square feet. The various parts are dropped into barrels or trucks, or go by chutes to others below. No spitting was noted.

*Curing Cellars.* — Each of the curing cellars (four or five in number) covers about 43,000 square feet. Here the pork is piled in stacks 20 or more feet square, and cured with salt; and the hams and bacon are cured

in tierces filled with a pickling solution of sugar, salt and saltpeter. These two processes require from thirty to seventy days.

The cellars are kept at a temperature of about 50° F. The floors are necessarily wet, but they are clean.

*Soaking and Washing Hams, etc.* — Before going to the smokehouse, the hams and bacon are sent to a large basement, where they are soaked in tanks of water and then washed with hot water and brushed. The floor is of cement, covered with wood. The light is poor.

*Sausage Making.* — The trimmings from the cutting room and "barrel beef" (government inspected) brought from elsewhere are mixed on tables, cut up by machinery, and mixed with salt, saltpeter and spices. The mixture is stuffed into casings, and the sausages are linked, boiled and sent to the smokehouse. The room in which this work is done is fairly well lighted, naturally ventilated and heated by steam. It covers 10,000 square feet. The floors, machines and all utensils are cleaned with hot water and brushes every day. A man leaving the room for any purpose whatever is obliged to wash his hands before resuming work.

*Preparing Pigs' Feet.* — In a room 25 by 30 feet 10 men and boys are employed scalding, scraping and treating pigs' feet. The nature of the work is such that the floors look untidy, but they are frequently cleaned and scraped.

*Rendering Room.* — In this department fat for lard is rendered in separate steam tanks, and trimmings and offal are tried out for grease in another set. The several products are drawn off from above, and the tank liquor and residue are discharged to floors below. The liquor is concentrated, and ammonia stock is recovered. The tankage is pressed dry, then further dried by steam, and the product is disposed of as fertilizer. The general conditions in this department are good, and the tanks and floors are kept in a clean condition.

*Box Making.* — The box factory occupies three floors of a building covering 15,000 square feet. The light is good and the ventilation excellent. Nearly all of the woodworking machinery is guarded, and practically every dust-producing machine is provided with zinc hoods and suction draft for the removal of dust and shavings. A dovetailing machine is not so provided, but to do so would be difficult, on account of its construction and manner of working.

*Brighton Abattoir, Boston. — Slaughtering and Rendering.*

This establishment contains a number of slaughtering and other departments, all owned by the corporation and let subject to its regulations. An inspector of the board of health of Boston is on duty all the time, and has absolute authority so far as its sanitation is concerned. He inspects and passes upon each carcass before it can be removed. The whole plant is in good order; it is properly lighted, drained and ventilated in every part.

The different slaughtering places vary in size, but are of practically the same construction. All have wooden floors that drain to a trough leading to the cellar. The blood is caught in this trough during slaughtering, and is converted afterwards into fertilizer. The cellars have cement floors, sloping

to points provided with strainers. They are flushed every night with a hose. All floors are scrubbed daily.

The offal is sent by chutes to appropriate places beneath the killing rooms, and is taken by a company which maintains a plant on the premises.

A number of those who slaughter here have cold-storage rooms operated from a central plant.

In addition to slaughtering and the treatment of the ordinary by-products, rendering and the manufacturing of oleo oil are carried on.

*Oleo Oil Manufacture.* — A basement, 75 by 35 feet, is used for sorting and trimming fat. The light, ventilation and drainage of the concrete floor are good. The fat is washed by cold spray and sent upstairs on an endless chain to the oleomargarine house, where it is ground, placed in kettles and melted. Next it is clarified and allowed to stand until the stearin separates, then is pressed through canvas and barrelled.

*Rendering.* — The offal from the slaughtering establishments and bones and fat from the markets are brought together in a basement, 170 by 60 feet, and sorted. Dead animals from outside are brought here also. The materials are taken to appropriate tanks, and heated until the fat separates. This is drawn off and is sold, chiefly to the manufacturers of soap. The tank residue is subjected to pressure, and disposed of as fertilizer. Sometimes the meat scraps are converted into poultry feed. The bones are cleaned and dried.

This department is clean and properly ventilated. The floors are swept when soiled, but are not washed except when all the tanks on one side are empty. All odors and gases are conveyed from the tanks by ventilation pipes to the furnaces, where they pass through the fire and are destroyed.

The men employed about the abattoir are of all ages, from twenty to sixty. All appear to be healthy. Very little spitting was observed. Many of the men eat their dinners in the workrooms or on the grounds.

*New England Dressed Meat and Wool Company, Somerville. — Slaughtering.*

This is a slaughtering and rendering establishment, which includes a number of departments. It is clean, and has good light and ventilation. A new system of toilet rooms has been planned, and will soon be installed. In this, the exit from the water-closets is a wash room provided with basins and towels, which visitors to the water-closets are obliged to make use of before returning to work. Such is the rule at present, but the arrangements are not so convenient as those planned. The departments of this establishment are described below.

The employees number about 250 on an average (350 when the plant is running to the limit of its capacity). They are of several nationalities, and all appear healthy. Very little spitting was observed in some departments, and none in others.

*Killing Room.* — Area, 8,840 square feet. Light and ventilation good. Occupants, 50 to 60.

The sheep are slaughtered in one part of the room, the cattle in another.

After slaughter the carcasses are hung, and the skinning and cleaning are completed. The meat does not touch the floor at all. The entrails are sent by chutes to the basement, each part by a separate chute. The blood runs to a channel in the floor and thence to the cellar. The floor is thoroughly scrubbed each day when the work of slaughtering is finished.

The carcasses are hung in a cooling room for about an hour before going to the large refrigerators. The floor of the cooling room is scrubbed daily. The refrigerators are given fresh sawdust daily, and are scalded every three or four weeks.

*Offal and Hide Cellar.* — The offal is handled by 20 men, and the hides by 30, in a cellar having an area of 36,400 square feet. The light is rather poor, and is chiefly electric. The floor is of brick and cement, and slopes for drainage to several strainers, and after the day's work is done it is washed down with a hose.

*Rendering House.* — The operation of rendering is carried on in a building of five stories, each with 3,744 square feet of floor space. The lighting is good in every part. The scraps, fat, bones, etc., are treated in rendering tanks in the top story. The fat is drawn off into barrels, and the residue is pressed and converted into feed for poultry, or subjected to more heat and pressure and converted into fertilizer. This building is clean in every part.

*Sausage-casing Room.* — The intestines are cleaned and scraped in a room 40 by 35 feet, and after being tested for perforations are salted. Condition, clean.

*Oleo Oil Making.* — The choicest fat after trimming and sorting is washed in several changes of water, then is ground and transferred to large steam-jacketted kettles, in which it is heated with constant stirring. It is then piped to kettles on the floor below, where it is clarified. Then it passes to another lower floor, where it is drawn into tanks and allowed to stand until the stearin separates, when it is pressed through cloths, for the removal of the stearin, and barrelled. The entire process is conducted with great regard for cleanliness. The kettles, tubs, tanks, etc., are thoroughly scalded and scrubbed after each time used.

These several operations are conducted in rooms of 2,700 square feet of floor space, in three stories. Each floor has drainage troughs, and is clean.

*Skin Cleaning.* — In a room with 8,900 square feet of floor space, provided with good lighting and ventilation, the skins are scrubbed and cleaned and the wool is removed. They are then put through several processes of curing. The floor is wet, but properly drained.

*Sturtevant & Haley Beef Supply Company, Somerville. — Slaughtering and Rendering.*

The building is of wood, and four stories high. The slaughtering is done on the ground floor, in a room about 50 feet square, by Jewish rabbis, and the product is "Kosher" or not, according to the findings on inspection. The animals killed are steers. The throat is cut and the head nearly severed by a single transverse cut of a heavy knife. The government inspector ex-

amines each carcass, as does also the rabbi, who rejects all animals with pleural adhesions, lung cavities or perforated viscera. Nearly all of the viscera go to the rendering tanks for grease and fertilizer, though a few livers and hearts are sold. The killing room has good light and ventilation, and is kept in a clean and neat condition.

The rendering tanks are in the upper story. The products are oleo oil, stearin, tallow and dried tankage.

The workmen have a healthy appearance, and spit very little.

*White, Pevey & Dexter Company, Worcester. — Pork Packing, etc.*

The various departments of this establishment are distributed among several buildings, chiefly of brick. At present the water-closets are in corners of workrooms, and no facilities for washing are provided; but on each of the floors arrangements are being made for adequate closets, the exits from which will lead into wash rooms provided with running water, basins, soap and towels. It is planned, also, to have cement floors and a ventilating shaft with an exhaust fan on the roof.

The *hog houses* are two wooden buildings, 40 by 80 feet and 30 by 60 feet, respectively, with two and three floors, respectively. Light and ventilation are good. The hogs are driven into the pens, where they are watered. The floors, now badly worn, but soon to be renewed, are washed down with a hose.

The *killing room,* 100 by 59 feet, has fairly good light and good ventilation and is heated by steam. The hogs enter from an inclined runway outside the building, and as soon as they are killed they are sent to a chute by which they drop into scalding water. The blood goes directly to a tank, in which it is reduced to fertilizer.

After the hogs are cleaned and opened they are examined by a government inspector, then split and hung up to cool.

The room as a whole is fairly clean, and is washed with more or less thoroughness every day.

The *cutting room,* 35 by 60 feet, is fairly well lighted, but is neither heated nor ventilated, it being necessary to maintain a low temperature.

*Soaking and Washing Room.* — This room, 25 by 75 feet, is in a basement and has a cement floor, sloping to drains in the center. The light is fair, ventilation good, and the heating is by steam. Here, hams from the curing cellars are soaked in tanks of water and washed off before being subjected to the smoking process. Here, also, all trucks, boxes, barrels, etc., are washed with hot water and brooms or brushes.

*Sausage Making.* — The manufacture of sausages is carried on by 12 workmen, in a room having a floor space of 1,350 square feet, fairly light, well ventilated and heated by steam. The machinery and utensils were found to be in clean condition. The wooden tables and trucks are to be replaced with galvanized iron. Many flies were observed.

*Preparation of Casings.* — In a poorly lighted but fairly well-ventilated steam-heated room, having 1,125 square feet of floor space, 10 persons are engaged in scraping (by machinery), washing and salting intestines for

sausage casings. The room is wet and unclean; and the air is unavoidably malodorous from the intestinal contents.

*Rendering Department.* — This occupies three floors, each of 1,250 square feet area. The light is poor, and ventilation is not specially provided for. The rooms are heated by steam.

On the third floor are six steam tanks, one of which is used for converting blood to fertilizer, two for trying out offal and three for lard. The grease is drawn down into settling tanks and coolers on the next floor. The tank liquor is drawn down into the basement floor, where it is evaporated to the consistency of thick glue, and later is added to the tank residue after the latter has been pressed and dried.

The employees are healthy looking, and spit but little.

*Springfield Provision Company, Brightwood. — Slaughtering and Pork Packing.*

This establishment is situated on the bank of the Connecticut River, and has its own water supply and drainage system. The buildings are more than twenty years old, and are not well arranged as to light, ventilation and facilities for cleaning. Alterations are in progress, which include the installation of several sets of closets and sinks. Hitherto, hot water, soap and towels have not been provided for the workmen. Excepting in the cold-storage rooms and smokehouse, the place is extensively infested with flies.

In the cold-storage rooms there is much condensation of moisture, and elsewhere an excessive amount of water is discharged on the floors, nearly all of which drain badly, and in consequence are very wet.

About 225 workmen, chiefly Poles, some Irish and French, a few Italians and native-born, have a fair to good healthy appearance. Not much spitting was observed. Sand boxes are provided for those who have the habit.

The time allowed for the noonday meal is a half-hour. Some eat out-doors in good weather, but ordinarily nearly all eat somewhere about the buildings. No place is provided for the purpose.

The establishment includes the following departments: —

*Hog House.* — This is a building, 225 by 60 feet, divided into pens 40 by 45 feet, capable of holding 90 to 100 hogs each. The hogs are seldom kept more than twenty-four hours before slaughter. The pens are washed down with a hose as soon as the hogs are sent to the killing room, and then are in fairly clean condition. Light is fair and ventilation good.

*Killing Room.* — This is a large room, 70 by 80 feet, in the top of the building. It is well lighted, and the ventilation is adequate. The hogs are driven up a long incline, and as they enter they are caught up by one leg and sent along a narrow passageway, where they are stuck in the neck. As they are carried along they bleed on the zinc-covered floor, from which the blood drains into a pipe. The carcasses are next dropped into scalding water, from which they are soon withdrawn, ready for the cleaners. After being scraped they pass along and are eviscerated. Each carcass is examined by two government inspectors, one of whom looks and feels for glands

in the neck, and the other inspects the viscera, which are thrown upon a table before him. The carcasses condemned and tagged are sent to the grease tanks. The viscera are sorted out and thrown into trucks, or sent below through zinc-lined chutes. The fat stripped from the intestines goes through a chute to the lard tanks.

After the day's slaughtering is completed the place is washed down with a hose.

Most of the workmen in this room work barefooted.

*Cold Room.* — Before being chilled in this room, which is 108 by 160 feet, and is maintained at a temperature of 30° F. or lower, the hogs are allowed to cool in a light and airy room, the floor of which is covered with sawdust and frequently cleaned. The cold room is lighted by electricity, and necessarily is not ventilated. It is divided into five sections, which are filled in turn. The floor slopes to a galvanized-iron gutter, which carries away the water used for cleaning. The hogs remain here about twelve hours, and then are sent to the cutting room.

*Cutting and Salting Room.* — This room, which has a floor space of 21,000 square feet, and is occupied by about 125 workmen, is properly lighted, but, because of the necessity of keeping a low temperature, is not provided with means of ventilation; but it is occupied but a few hours at a time. Here the carcasses are cut up and distributed, and meat is stacked for dry-salting or placed in barrels for storage. The floor is wet, but is said to be cleaned every day or two. Sand boxes are provided, and no spitting on the floor was observed.

*Trimming Room.* — In this room, which is 108 by 65 feet, properly lighted, and maintained at a temperature of about 35° F., 50 persons are engaged about three hours daily trimming small pieces of meat. The room is clean.

*Preparation of Sausage Casings.* — This work is carried on by 10 persons, in a room with good light and ventilation, having a floor space of 1,200 square feet. The intestines are scraped, washed, tested for perforations and packed in salt. The room is kept clean, and is not more odorous than is to be expected, considering the nature of the material treated.

*Soaking and Pickling Cellar.* — Here, in a temperature of about 40° F., hams and bacon are soaked for from forty to seventy days in a pickling solution of salt, sugar and saltpeter. They are then taken out, soaked in water, washed with cold water and a stiff brush, and then carried to the boning rooms. The floor is of cement, with a board covering.

*Boning and Trimming Rooms.* — Here the bones are removed from the hams, which are then placed in tin holders, in which, before being taken to the smokehouse, they are boiled. This department includes several rooms, properly lighted and ventilated, each about 25 by 50 feet.

*Sausage Making.* — Five rooms are given up to the manufacture of sausages. They are all fairly well lighted and ventilated, and have floor spaces ranging from 800 to 2,250 square feet. They are heated by steam. In the cutting and mixing room, 40 by 50 feet, the meat from the trimming rooms is mixed with government-inspected-and-stamped "barrel-beef," salt, saltpeter

and spices, and ground by machinery. No other preservative substances are employed. The casings are filled in a second room, 30 by 75 feet, and the sausages then pass to a third room, 30 by 40 feet, where they are boiled in a wooden tank. They are packed in another room, 20 by 40 feet, and then placed in cold storage. The greater part are smoked in the smokehouse. The floors of the sausage rooms do not look clean, but they are said to be washed daily with water.

*Rendering Lard and Grease.* — Eight tanks are in use: five for lard, two for grease and one for blood. They are on the third floor. Portions of three floors are in use. When the tank contents have been heated sufficiently long, the fat is drawn off at the upper level and the water and residue through the bottom. The lard and grease go at once to settling tanks below. The lard, after appropriate treatment, is pumped to the filling room, where it is run into pails. On the lower floor the tank water is drained away, and the residue is pressed and dried for fertilizer.

*Preparation of Pigs' Feet.* — Six men, in a properly ventilated and fairly well-lighted room, 30 by 45 feet, clean and shave scalded pigs' feet. The place naturally is wet and somewhat dirty, but otherwise is unobjectionable.

*Washing Room.* — All trucks, utensils, etc., are taken every night to a room 30 by 60 feet, where they are washed with warm water and stiff brushes. The proper cleaning of wooden trucks and tubs is not a simple operation, and 5 or 6 men are engaged at this work every night.

*Springfield Rendering Company, Brightwood. — Slaughtering and Rendering.*

In this establishment, which occupies a brick and wooden building two stories in height, situated on the bank of the Connecticut River, the chief business is rendering. The slaughtering is done by Jewish butchers, each killing his own animals, and the meat is "Kosher." The animals slaughtered are chiefly cows and calves, and they number about 50 per week. They are kept in a small, not clean yard, from which they are driven up a short incline to the killing room, the floor of which is double, and slopes slightly to drain in the middle. This drain has two plugs, one of which closes the opening to the rendering tanks (for blood), and the other that of the outlet for wash water, which drains to the river.

The killing room is cleaned by the company when the day's slaughtering is completed. Since those who use the place kill at all hours of the day, it is difficult to keep it in a cleanly condition, and the place is infested by flies. The rabbi makes his inspection at the time of slaughter, and a second inspection is made by the local inspector. The carcasses are carried away, not chilled, within a few hours, although a cold-storage plant is maintained on the premises.

The company makes oleo oil from suet and fat collected in the markets and sent in in ice. This material is trimmed and washed and put into steam kettles, after being finely minced by machinery. It is heated to 170° F. for several hours, and the liquid fat is drawn off into wooden tanks. After the stearin has separated, the material is pressed through cloth and the oil is

conveyed to a storage tank, from which it is drawn into barrels for export. The stearin is used in this country for various purposes. The building in which this work is conducted is clean and neat throughout.

Another operation conducted here is that of bone grinding, in which process much fine and irritating dust is evolved. One man manages the machine, and has done so for three years without discomfort or injury.

The chief business is curing hides and rendering. The products are hides, bones and bone dust, stearin, oleo oil, fertilizer and ammonia stock.

Following are the reports on 201 of the small slaughterhouses in 107 cities and towns. The places visited are arranged in alphabetical order. The results speak for themselves, and they are presented without comment; but attention must be called to the fact that the provisions of the law relative to slaughtering are very generally ignored.

Thus, section 99 of chapter 75 of the Revised Laws provides that the proprietor of every slaughterhouse shall apply annually, in April, to the local authorities for a license, stating in his application, which must be in writing and properly sworn to, the estimated number of animals to be slaughtered per week and the days of the week upon which they are to be slaughtered. Section 100 provides for the issuing of the licenses. Section 101 prohibits slaughtering on any days other than those specified in the application, except in the presence of a member of the board of health or of an inspector appointed for the purpose by the board; section 102 provides for the presence of the inspector and for examination of the carcasses at the time of slaughter. Section 105 exempts those who, not being engaged in such business, slaughter their own animals on their own premises, but it provides for proper inspection of the carcass of any animal, more than six months old, which has not been inspected under the provisions of another law within six months. Section 106 provides a fine of not more than $500 or imprisonment for not more than sixty days, or both fine and imprisonment, for slaughtering without a license, or for neglecting to cause carcasses to be inspected, or for selling a carcass or part thereof that has not been inspected. And yet many of the proprietors of the slaughtering establishments described below hold no licenses; some of the places are used by an indefinite number of unlicensed butchers from neighboring cities and towns; an inspector is rarely present at the time of slaughter; in not a few instances the person appointed as inspector is the licensee himself; sometimes the inspector is sent for and calls on the following day; sometimes meat condemned in one place is removed to another town and there inspected, passed and stamped for a small fee per carcass; and more often carcasses are not inspected at all, and consequently are not condemned, even though showing evidence of disease.

*Acton.*

1. Slaughterhouse, 25 by 20 feet, which contains two pens for cattle, a cooling room, and a refrigerator, 10 by 12 feet. At the time of visit the latter was in good condition and contained a dozen fair-sized dressed calves. Four calves were confined in one of the pens; 2 of them were very small.

The floor has a trench in the centre, with a slight slope; a trap door communicates with the cellar. Part of the offal and blood is given to the hogs in the cellar, and the rest is carted away and buried. There was some whitewash on the walls, but the floor, benches and utensils were very dirty, and the place was infested with flies and had an offensive smell.

About 40 cows and 80 calves are killed here each month, and the meat, which is retailed in Lowell, is stamped by an inspector.

*Agawam.*

2. A small slaughterhouse; area, 500 square feet. Tight wooden floor about 18 inches above the ground, without noticeable pitch. At one end there is a door, through which the blood and offal are pushed out onto a platform in a hogpen. The platform is said to be cleaned every day, so that the hogs shall have only fresh material to eat. No ventilation. Walls and floor of the slaughtering room very dirty. Room infested with flies.

About 35 cows and 20 calves are killed here every week. The cattle are kept in a small yard, pending the arrival of the butchers, who change their clothes in a small, dirty room, 6 feet long by 8 feet wide.

A large piggery extends from the slaughterhouse for several hundred feet, and the pigs come up and feed at the platform.

*Alford.*

3. The slaughterhouse, 30 by 30 feet, occupies half of a dilapidated barn, the other half of which is used as an icehouse. In one corner is a platform, 12 by 14 feet, of broken and loose boards. This is the only portion of the room which has a floor. Adjoining is a hogpen, beyond which are a meadow and a brook. The blood and offal go through a hole into the hogpen, from which the drainage passes into the brook. The refrigerator, 6 by 8 feet, at the time of the visit contained many scraps and salted hides, and was in an unclean condition. The place, generally, was in a condition of clutter, and here and there were scraps of decaying meat, old heads and hoofs.

The local inspector of animals comes when sent for to look at the slaughtered meat.

*Amherst.*

4. Small slaughterhouse in a barn, where 10 calves per month are killed in spring and early summer. It has neither floor nor cellar. The offal is fed to hogs.

5. Building 20 by 30 feet, in a field half a mile from the town. The floor slopes to one side, where there is an opening for the escape of blood, and also a hole through which the offal is pushed into a hogpen. Heads and bones are thrown to the hogs, and also occasional carcasses of dead horses and diseased cows. After a time the bones are gathered and sold.

Thirty calves and cows are killed monthly, mostly by butchers from Holyoke, who kill for their own trade.

There is a driven well on the premises, but no cleaning is done, and the floor is very dirty and has a foul odor. In the corner of the slaughtering room is a common privy, used by those who do the butchering.

The local inspector asserts that carcasses rejected by him are carried to the inspector in a neighboring town, and stamped at a uniform rate of five cents for each animal.

6. Killing is done in a barn cellar, in a space 15 by 20 feet, with cement floor partly covered with sawdust. On one side is a large collection of manure, and on the other side is the hogpen. The liquid from the hogpen runs onto the floor of the killing area. The offal is thrown to the hogs. During the busy season the average killing is about 30 calves and cows per month. Sawdust is used to absorb the blood, but practically no cleaning is done.

7. Slaughtering done in one end of a new barn, in a space 20 by 15 feet. About 20 calves per month are killed. The offal and blood pass through a trap door to hogs in the cellar. The floor gets no cleaning, but the work is conducted in a comparatively neat manner, and but little blood and filth were observed. General condition fair.

*Andover.*

8. Building 20 by 30 feet, with section having a sloping floor and a side door overlooking a hogpen. The floor is in good condition and is fairly clean and covered with lime. The place is not used much in hot weather, but in the busy season about 20 calves and cows per month are killed. The refrigerator, 15 by 15 feet, is clean. The hides and heads are carted off by a rendering company. In a room adjoining the slaughterhouse are accommodations for 6 cows. But few flies were observed.

9. Portion of barn, 15 by 35 feet, is partitioned off for use as a slaughterhouse. Up to the time of inspection, only chickens had been killed

and dressed. The place is dark, and in an untidy condition from blood and feathers. On the day of visit 3 cows were waiting to be killed, 1 of which was exceedingly thin and had a suspicious cough.

*Arlington.*

10. The slaughterhouse has good light and ventilation, and is sweet and clean. It has a tight floor which slopes to one side, where a channel connects with the sewer. About 50 to 60 calves are slaughtered every week. The offal is removed at once and the entire place is cleaned every day after slaughter. The calves are dressed and cooled in the same room and then removed to a clean ice chest. No odor was observable.

*Ashburnham.*

11. On a barn floor, 20 by 35 feet, about 25 calves per month are killed. Underneath is a hogpen. The place is supplied with running water, and the floor is washed clean. The refrigerator, 10 by 12 feet, is clean, and has sawdust on the floor to catch drippings. The offal is converted into poultry feed. A clean, well-kept place.

*Ashfield.*

12. The slaughtering is conducted in a portion of the barn, 8 by 15 feet, partitioned off. From 6 to 12 lambs, raised on the premises, are slaughtered each week during the late winter and the spring months. There is no drainage, but the offal is carted away to hogs, or buried. The place is exceedingly dirty, and the floor is covered to a depth of two inches with accumulated filth.

13. Shed, 22 by 15 feet, situated in a field. A few cattle, sheep and calves are killed each week. The offal is given to hogs in a pen beneath. Very little cleaning appears to be done. Floor very dirty. At the time of visit many flies were present, and a bad odor was noticeable about the whole place.

*Ashland.*

14. The slaughterhouse is a room, 25 by 16 feet, with a wooden floor. A trap door communicates with a shallow cellar, in which the refuse is thrown and covered with dirt and sawdust. The cellar drains to a cesspool fifty feet away. About 50 animals, condemned by State authorities, are killed and destroyed each year. Also, in the busy season, from October to May, from 40 to 75 hogs, calves and cows are slaughtered.

The floor is scraped clean and dry. The walls are clean. Water is brought for cleaning purposes in barrels. The earth and sawdust covering keep the cellar in good condition, and, in general, the place is fairly clean, and remarkably free from flies.

*Athol.*

15. Small shed in a field on the outskirts of the town. About 300 hogs, 30 cows, 20 sheep and from 30 to 40 calves are killed yearly. The shed is about 15 by 20 feet; open on one side, and has a rough board floor. In a corner is a kettle for heating water. The offal is removed in a wheelbarrow and buried. Although the place gets no real cleaning, it is in fair condition.

*Attleborough.*

16. Slaughterhouse, 20 by 12 feet, situated in a barn. A trap door communicates with a shallow cellar containing manure. The general condition is very dirty, although the place appears not to have been used for slaughtering purposes for several weeks.

*Auburn.*

17. Small establishment, used only for the killing of an occasional old horse. No regular butchering done for more than a year.

*Barnstable.*

18. About 25 to 35 calves and hogs are killed, from October to March, on a barn floor, 20 by 20 feet. There is no cellar. At the time of visit there was little evidence of recent use and the place was fairly clean.

19. The slaughtering is done in a wooden annex to a barn. The room is 22 by 15 feet, with a good board floor, and has a cellar beneath. From 40 to 50 calves and 12 to 15 cows are killed annually. Little slaughtering is done in summer. Some of the offal is carted out and buried on the farm; some is given to hogs. At the time of visit the place had not recently been in use, and was in a fairly clean condition.

20. Wagon shed, 22 by 30 feet. The only indications of the use to which it is put are hoisting tackle and hooks, and the place is very clean. Only calves and chickens are killed. All offal is carted off into the woods, and covered from time to time with ashes.

21. Calves are killed on a barn floor, which, after use, is thoroughly cleaned, and shows no evidence of the use to which it is put. The proprietor keeps a provision store on the opposite side of the street, and here his meat is sold. The store is clean. All offal is carted away into the woods.

22. Calves slaughtered in a wagon shed back of a provision store. The place is thoroughly clean and shows no evidence of the use to which it is put. All offal is carried away into the woods and disposed of.

23. Slaughtering of hogs out of doors near the barn. No evidence of slaughtering observed at the time of visit.

24. Hogs slaughtered in a wooden building, 10 by 20 feet, from October to March. Blood and water run into a shallow pit near by and are mixed with sand. This is cleaned out in the springtime. The rest of the offal is thrown into a hogpen. At the time of visit the place was fairly neat and clean.

25. The slaughterhouse, 20 by 20 feet, is an annex to a barn. It has a fairly good wooden floor, which pitches slightly to a side door, through which the offal is pushed out to swine. At the time of visit, little slaughtering, except of chickens, was being carried on; but during the year, from 40 to 50 calves and a large number of pigs are killed. The floor is cleaned, but the walls at the time of inspection were dirty and bloody.

26. A group of old buildings in a field. (The original Swift slaughterhouse.) These buildings have been cleaned and whitewashed, but the whitewash has been laid on over pre-existing dirt. The killing is done in a room 30 by 35 feet, which has an old rough floor. The light and ventilation are good. The place is used, in addition, for curing pork, and as a storehouse for meat and provisions. The refrigerator, 15 by 20 feet, is in fair condition. The bones, heads and offal are thrown onto the ground out of the most convenient door, but in summer all this material is said to be buried. About 75 calves and 12 cows are killed during the season. Water, when used, is obtained from a well outside.

*Bedford.*

27. Portion of barn used for killing hogs in the autumn months. At the time of visit there was no evidence of slaughtering.

*Belchertown.*

28. Slaughterhouse, 10 by 20 feet, in one end of a large barn. A trap door communicates with the cellar and hogpen below. The pen opens on one side, and is less objectionable than the average pen. The bones and offal are thrown to the hogs. From 10 to 25 calves per month are killed. There is not much cleaning, but the blood and dirt are covered with hay and sand, etc.

A new slaughterhouse, 25 by 16 feet, is being built, and this is to have a cement floor.

29. Slaughtering done in portion of barn, 18 by 22 feet, with sloping floor, which gets no cleaning except such as can be done with a broom; consequently, it is not in good condition. The walls and benches are covered with dirt and blood. The offal goes to hogs on the farm. About 30 animals per month are killed. In another building there is a kettle for rendering. The condition of both buildings is dirty.

30. From 12 to 15 cows and calves are killed monthly on the floor of

an old barn. The blood and offal, which are fed to hogs in a pen outside, are collected in a wooden trough and metallic bucket. There is little evidence of the use to which the place is put. No spattered blood or filth observed. Place fairly clean.

*Beverly.*

31. A dilapidated shed, 30 by 15 feet, partly floored. The unfloored portion contains about a foot of wet, slimy manure; back of the shed is a hollow filled with the same material. The place has been in use for many years, but it shows no evidence of having been cleaned in any way. It is situated near the street, through which runs a water main; but what water is needed is brought in pails. The offal is said to be buried; the hoofs, heads and grease, etc., are sold to renderers.

*Billerica.*

32. Slaughtering done in a room, 12 by 20 feet, in the end of a barn. The offal is thrown through a trap door into a cellar below, where it is eaten by hogs. Twenty-five calves per month are killed and inspected by the town inspector. At the time of visit 3 exceedingly small calves were waiting to be killed. It was said that one of them was to be killed only for its hide. The general condition of the place was dirty.

33. Slaughtering done in a building in a field near the town. The killing room is 20 by 30 feet. About 10 calves per month and 100 hogs and 6 cows per year are killed and inspected. A refrigerator, 12 by 8 feet, is in fair condition, but the slaughtering room and the cellar below are exceedingly dirty, no cleaning being done. The offal is sold.

*Boxford.*

34. A fairly good building, 20 by 18 feet, used in autumn and winter for killing hogs. About 60 to 100 are killed during the season. At the time of visit the place was clean and in good condition. The cellar beneath is open on one side and is well lighted. This also was clean.

35. The slaughterhouse is a dilapidated old building, 38 by 20 feet, with a rough floor. In the cellar beneath, and elsewhere on the premises, are kept hogs, which are fed on swill. Back of the slaughterhouse is a brook, which receives the drainage of the place. The floor of the slaughterhouse is covered with dried blood, manure and other dirt, and in the corners are old rags, papers and discarded tools.

The animals slaughtered include cows, hogs and calves. The number could not be ascertained, but it was estimated that hundreds are killed during the year. The meat is used to a great extent in a sausage factory in Lawrence.

*Bridgewater.*

36. A few calves (not over 20 per year) are killed in the end of a barn. Floor covered with dirty sawdust; old blood stains observed on the doors and walls. At the time of visit no killing had been done for some weeks.

37. In a dilapidated out-building, 16 by 20 feet, hogs are killed in winter. There is a room for hanging meat to cool. The floor is of loose boards and is not cleaned.

*Brockton.*

38. This is an extensive establishment, with cattle yards, refrigerators, and a sausage factory. The cattle come from Vermont and New Hampshire, and a few are collected in the neighborhood. The average number of animals killed is 125, — 50 cows, 50 hogs and 25 calves. The slaughtering room, 20 by 50 feet, has a trap door through which some of the offal goes to hogs below; the rest is buried in the woods on the farm. The slaughtering floor is washed with hose after use, but the walls and utensils are left dirty. The floor is level and drains off poorly. The light is very good. The refrigerator is fairly clean. The sausage factory was not in use at the time of visit, and was in fairly clean condition.

*Cambridge.*

39. The slaughterhouse is a shed, 16 by 22 feet, in the rear of a barn. It is kept scrupulously clean and is quite free from odor. It has a tight wooden floor which slopes to a strainer in the centre. About 40 to 50 calves are killed per week. The offal is removed immediately and the meat is inspected by the Cambridge inspector before it can be sent out.

40. An old slaughterhouse, with good light and ventilation. A wooden floor slopes to a door, where the drainage is caught in an iron tub. The offal is removed in barrels on the day of slaughter. The floor is scraped after each day's work, and is clean. When visited, the walls were found to have been whitewashed recently and were in good order. The cutting board, barrels for offal and meat hooks were not clean, and many flies were observed. About 100 calves per week are killed. The general conditions are fair.

41. A small establishment, with a floor space of 450 square feet. The wooden floor slopes to a strainer, which is connected with the public sewer. The floor is clean, but the walls near the door are greasy and bloody for about two feet from the floor. General conditions are fair.

*Chelmsford.*

42. Twenty calves and a few cows are killed each month in a slaughtering room in a barn, with a fairly good floor and trap door to cellar below. The floor is cleaned to a certain extent, and has lime sprinkled over it. The cellar beneath is entirely without light. At the time of visit it contained a foot or two of semi-liquid manure and a half dozen pigs, which are fed on offal from above. The heads, hoofs and hides are carried away by a rendering company.

43. A barn, 35 by 30 feet, with an earthen floor, is used at times for killing calves. Not more than 6 per month are killed in the summer months. At the time of visit there was not much evidence of the business.

44. Slaughterhouse is a building 45 by 15 feet, with a loose board floor. About 1,000 swine are killed here during the year, but not in summer, during which season a few calves are slaughtered. A boiler in a room adjoining the slaughtering room furnishes hot water, some of which is used for washing the premises. Floors and walls fairly clean.

45. A comparatively new barn, with a room 20 by 30 feet, the floor of which contains a slit and a trap door, through which the blood and offal go to the pigs in the cellar. The pigs have an outside yard as well. From 20 to 30 calves and 6 to 8 cows are killed every month. The place is not clean. The cellar beneath has a cemented floor, on which is a foot or more of wet manure. The outside pen is fairly dry.

46. Slaughtering done in a shed connected with a house and barn. In one side of the shed there is a hole which leads to a wooden chute, which carries the offal below to hogs. The floor is scraped a little, but no other cleaning is done, and the whole floor is covered with a mixture of blood and manure, hair and grease. The entire place is very dirty, infested with flies, and foul smelling. The number of animals slaughtered per month is from 20 to 30.

47. Slaughtering carried on in the end of a barn, 36 by 12 feet, with a slightly pitched floor and drain in centre. The offal goes to a hogpen below in winter, but in summer it is carted to a hogpen in a field near by. The walls and sides are not cleaned at all. The floor is cleaned with water brought in pails, and a dry powder, said to be "antiseptic," is used to keep down odors. The heads, hoofs and hides are carted away by a rendering company, but the offal is mixed with cotton waste in the cellar, which has a cemented floor, which helps to retain the moisture, and in consequence the contents are in a very bad condition. The number of animals slaughtered monthly is about 30,—10 cows and 20 calves.

48. The slaughtering room is a corner of a large, fairly clean barn,

and is 12 by 15 feet, with a floor pitching to the centre. When visited it had been whitewashed and was fairly clean, and lime was sprinkled on the floor, upon which 60 to 70 cows and calves are killed per month. The refrigerator, 7 by 12 feet, was in fair condition.

Under the slaughtering room there is a cemented cellar, which was in a wet and nasty condition. The drainage runs back through a ditch to a cornfield. The contents of the cellar are said to be mixed from time to time with cotton waste. The place has a good water supply, and is equipped with a hose for cleaning purposes.

*Cheshire.*

49. Small building back of a barn, with earth floor. Slaughtering room, 11 by 24 feet, was found to contain some decomposing bones and hoofs. Although there is an abundance of water in the barn, little appears to be used, and the place is dirty. About 20 to 30 calves per month and 30 to 40 cows per year are slaughtered. An inspector is sent for to stamp the cows but not the calves. The meat is sold in Adams. In winter, the hoofs and bones are sold to a rendering company.

50. Slaughtering is conducted in a place, 20 by 30 feet, in the end of a wagon shed, which has a cemented floor. About 20 calves per month are killed. The offal goes into a hole near by, and is covered with earth and charcoal and frequently carted away and buried. Town water is used, and the place is kept fairly clean. The meat is not inspected.

*Clinton.*

51. Wooden building, 26 by 40 feet, in a field on the edge of the town. It has a refrigerator, 10 by 15 feet, and a cooling room of the same size, as well as a kettle room for heating water. The killing floor is 15 by 25 feet; it has a trap door in the centre, which communicates with the cellar beneath. A hogpen in the rear is open and clean. The offal is carted off to a piggery in the country; the heads and bones are sold. About 150 calves per month come from Vermont and are slaughtered here; some also are collected from towns near by. In addition, about 20 sheep per month, and 12 cows, and 100 to 125 hogs per year are slaughtered. The meat is stamped by an inspector before being shipped to Boston. The middle of the floor is cleaned somewhat. The walls, doors, tables and utensils are dirty and foul smelling, and the place is infested with flies.

*Concord.*

52. Building 22 by 14 feet, about one-fourth of a mile from the road. It has a rough floor, with a trap door in the centre and a dark cellar beneath, in which are pigs which are fed on the offal. The re-

frigerator, 10 by 12 feet, is dark and not very clean. About 50 calves and 12 cows per month are slaughtered, and the meat is sent to Lowell, where it is sold from carts. The carcasses are inspected. Heads and hoofs are sold. Cotton waste is thrown into the cellar below, to keep the manure as dry as possible, but the cellar and the whole place are exceedingly dirty and foul smelling, and overrun with flies.

*Conway.*

53. Market on Main Street in Conway, under which is a room, 25 by 30 feet, with a cemented floor draining to the centre, and through a pipe into the river. Calves, lambs and poultry are killed each week. A fairly good place, but not well kept, being dirty, untidy and infested with flies. In an old barn, somewhat more than a mile distant, 3 or 4 cows are killed each week on a floor 12 by 16 feet. The place is very dirty everywhere, and apparently no attempt is made to clean it. There is no water supply except that which is brought in in cans. All offal is thrown to the hogs under the barn.

*Cummington.*

54. Building 20 by 40 feet, in the woods. The floor at one end slopes, and has a trap door through which the blood and offal go to hogs in the cellar, which is wet and dirty, but the hogs have a large yard outside. The animals slaughtered here include cows, calves and sheep. Little cleaning is done except to push the offal into the cellar, and consequently the floor and walls are covered with old blood and dirt. The hides are salted and piled up in one end of the room. Near by is a shed, 15 by 12 feet, where calves and chickens are killed. When the killing is finished, an inspector is sent for. He arrives usually the next morning, and inspects the meat and stamps it. This is kept in a more cleanly manner, but is, nevertheless, dirty. Most of the meat is sold in the local market.

*Dalton.*

55. Slaughtering is conducted in a part of an addition to the barn; floor space, 28 by 15 feet. There is a hole in the wall, through which offal and blood are pushed into tubs, and removed for burial or for feeding to hogs. The floor appears to have been scraped, but no other cleaning is done, and the walls are very dirty.

56. Slaughtering conducted on a part of a barn floor, 20 by 15 feet, which slopes to a square hole, through which blood and offal are discharged into the cellar, where hogs are kept. Little slaughtering has

been done during the past year, — not over a dozen calves and cows. The floor is said to be cleaned with a broom, but at the time of inspection it had not properly been cleaned since when last in use.

*Danvers.*

57. A well-built slaughterhouse, connected with a barn, and reached by passing through the stable. The killing-room is 22 by 20 feet. The wood work is in good condition, but shows no evidence of any process of cleaning, being covered with dirt, blood, filth and grease. The floor has a slit about an inch in width, through the center, through which the blood escapes to a hogpen below. About 25 calves are killed per month. The heads, hides, hoofs, horns, bones, fat and offal are taken away by a rendering company.

58. Shed, 17 by 25 feet, connected with a house and barn. The floor is of double thickness, and slopes to a gutter which discharges into a trough outside, which overflows onto the ground. The offal is carted away to a hogpen in the woods. The place shows no evidence of ever having been washed, but the floor is scraped every day after use. The walls and ceiling are so covered with spots of blood and filth that it is hardly possible to see the wood itself.

*Dartmouth.*

59. This establishment is a comparatively new, well-lighted building, 15 by 25 feet, where from 10 to 20 cows and a larger number of calves are killed each month by a number of butchers. The floor appears to have been scraped at some time, but it and the walls, doors and windows show abundance of blood, dirt, hair, manure and grease. The offal is pushed through a hole in the wall into a pigpen, a large portion of which is filled with a wet mixture of manure and pieces of offal. The building is not supplied with water, and if any water is used, it is brought from a spring two hundred and fifty yards away. The foul odor arising from this establishment is perceptible at a distance of one hundred yards in all directions.

60. The slaughtering room is 20 by 30 feet, in the end of a barn. It has a rough board floor, and beneath is a cellar. Here about 30 to 40 calves are killed per month, and about 500 hogs during the season. The offal is thrown to hogs in the cellar beneath, in which there is wet manure to the extent of a foot in depth. The slaughtering room is said to be washed with water brought from a well outside, and a small place in the middle of the floor bears evidence of having been washed to a

slight extent; but the rest of the place, the walls, benches, doors and floor, are covered with clotted blood, manure and dirt.

61. A comparatively new slaughterhouse, 20 by 28 feet, situated in a meadow, a quarter of a mile from the owner's house. The slaughtering is done by another person, who has no license. No definite information could be obtained as to the number of animals slaughtered, but it would appear that from 40 to 50 a month are killed. The floor is fairly good and appears to have been scraped, but the rest of the place is very dirty in every part. The offal is pushed through a hole in the wall directly onto the ground outside, where it is mixed to some extent with seaweed. The surroundings are dirty, and the odor of the decomposing offal is perceptible for more than one hundred yards. If any water is used in the establishment, it is brought in in a single milk can. In the meadow, close by, on the day of inspection, a sick cow was observed, lying with head on the ground, and breathing forty times to the minute.

62. This place is a room, 18 by 28 feet, in a dilapidated old barn, in which are three stalls containing about two feet of manure. The floor is rotten and broken in places. The floor, walls, benches and everything else are covered thickly with manure, blood and other filth, and there is no evidence that any cleaning is ever done. The offal is said to be carted away to a farm. The cellar beneath the slaughterhouse is filled almost to the top with manure. The place is owned by a local official, and is used by a number of butchers, who hold no license to slaughter. About 15 cows per month are killed, and an unknown number of calves, the latter not inspected.

### *Deerfield.*

63. Wooden building, 25 by 50 feet, with a ventilated slate roof. About 300 hogs, 300 beef cattle and 500 calves are slaughtered in a year, in a room, 15 by 25 feet, with a tight wooden floor pitching to a drain in the centre, through which blood, etc., are conveyed to a receptacle outside. This floor is kept in a clean condition. The meats are hung in a cooling room, from which they pass to a large refrigerator.

Lard is tried out in a steam kettle; hams and bacon are cured in the cellar, which has a cement floor; and beef is corned in another room.

The whole establishment is clean and well kept, and is free from flies. No spitting was observed.

64. Shed, 12 by 18 feet, in a field. It has a cement floor, which is kept in a clean condition. Ice-box connected with building is clean. The place is used for killing calves.

*Dighton.*

65. A license has been taken for the purpose of killing 4 or 5 calves and about 6 hogs per year. Work is done in the barn or in the yard, and no live stock is bought for slaughtering.

66. About 30 calves per month and 20 cows per year are killed in a corner of a new barn, in a room 12 by 16 feet. Beneath is a cellar, in which are kept hogs, to which the blood and offal are given. The heads and bones are sold to a rendering company. The source of water supply is a well in the yard, but no water is used and the floor gets no cleaning. The walls and utensils are spattered with blood, and the floor, to the depth of more than an inch, is covered with clotted blood, hair and manure. The refrigerator, 10 by 8 feet, dark and not clean, is situated in a separate building.

*Dracut.*

67. In one of several poorly kept barns and sheds, cows, calves and pigs are slaughtered on a floor 14 by 20 feet, with a trap door to a shallow cellar, to which hogs have access. On the day of inspection the floor had recently been cleaned and sprinkled with lime. About 10 cows per month and as many calves as can be obtained are slaughtered. The place is not regularly cleaned, and the drainage goes into the yard. Part of the refuse matter is boiled for chicken feed.

68. Wooden building constructed for the slaughtering business. It has a room, 35 by 18 feet, with a slightly sloping wooden floor. In one of the walls is an opening near the floor, through which the offal is pushed out, to fall onto a platform in a hogpen twenty-five feet below. There is also a slit in the floor, through which the blood goes into a barrel beneath. In warm weather all offal is carted away to a hogpen in a field. The refrigerator, 10 by 12 feet, was found to be in fair condition.

There is a steam boiler on the place and hot water is used in cleaning the walls and floor. On the day of inspection the walls had recently been scraped, and the accumulation of blood thereon had been reduced in amount. Under the slaughtering room is a place for salting hides, and beneath this is another roof, and both were found to be in fair condition. Next to the slaughtering room is a tie-up for 6 to 8 cows, but it is well separated by partitions. The water supply is derived from a well, which is piped to the barn and slaughterhouse. The drainage goes one hundred yards back, into a meadow.

The inspector of animals, etc., comes "now and then," but does not see all that is killed and sold.

69. Slaughtering done on the barn floor near a door. Six to 10 calves per month are killed. The hides, heads, etc., are removed by a rendering

company. The offal is mixed with earth and allowed to decompose under ground. The floor is washed sometimes with water from the well.

70. On the day of visit the place was not yet ready for business, the barn floor being about to be relaid.

71. Slaughtering is done on the main floor in the barn. The offal is brought into the cellar beneath, where hogs, which also get city swill, are kept. A few pigs are kept in a pen close to the slaughtering place. On the day of visit 1 very thin, small calf was waiting to be killed. The place seems to get no cleaning, but apparently not much slaughtering is done in summer, and less than the usual amount of blood and filth was found on the floor and walls.

72. Slaughtering done in a place, 20 by 30 feet, partitioned off on one side of the barn. There is a trench in the floor and also a trap door to the cellar beneath, where pigs consume the offal. The hoofs, heads, hides, etc., are removed by a rendering company. The cellar is filled with slimy matter and wet manure. The entire place is very dirty and shows but a limited space where any cleaning is done, everything else being covered with blood, grease, manure and dirt. There is no refrigerator. About 20 calves per month are killed by different butchers during the summer, but many more, and also pigs and cows, are killed in cold weather. At the time of inspection 3 or 4 immature calves were awaiting slaughter.

*Duxbury.*

73. Although, formerly, slaughtering was done at this place for a butcher in town, at present only a few very small calves are killed for their hides, the meat being given to pigs and chickens. Slaughtering is done in a barn back of the horse stalls, in a space about 20 by 12 feet. The offal is discharged into a cellar, where it is buried in the manure. The conditions found were unobjectionable.

74. Slaughtering done in Bailey's barn, in the southern portion of the town. About a dozen sheep had been killed up to the time of visit, but it was anticipated that the business would be greater later on. The premises show little evidence of the business, blood, etc., not having been sprinkled about. The barn is small and the work has been done near the door. Offal is buried beneath manure in the cellar.

*Egremont.*

75. In a small building, 12 by 18 feet, with a rough floor, 3 lambs are killed each week. The place is kept free from evidence of slaughtering, ashes or earth being spread on the ground over any blood or drippings. The offal, heads, etc., are carted away.

76. A slaughterhouse occupies part of a building, the other portion of which is a market. Between these two establishments are two doors. The market is clean, as is the refrigerator, 10 by 12 feet, which on the day of inspection contained meat of good appearance and quality. The killing room, 18 by 30 feet, has a cement floor, and here from 40 to 60 calves, cows and lambs are killed. The offal goes through a hole in the wall to a hogpen outside. The floor of the killing room is cleaned a little with water brought from a trough in the barnyard. The walls, tables and doors are very dirty and bloody. When visited, there was considerable rubbish and decomposing meat lying about, and a barrel containing entrails and meat scraps, swarming with maggots, stood in the centre of the room. The odor was extremely offensive. Bones and heads are sold to a fertilizer company.

*Essex.*

77. Slaughterhouse in part of barn; area, 15 by 12 feet. The sloping floor drains to the cellar. The place is clean, and in good condition. The floor is kept well washed.

*Fall River.*

78. In a wooden extension of a rendering plant is a room, 40 by 35 feet, used by a number of butchers, who kill, at all hours of the day or night, from 50 to 150 cows, 50 to 75 calves, and a few sheep every month. A rendering company holds the license, and cleans up with hot and cold water and a hose every day; but, owing to the unclean methods of the butchers, the place is frequently very dirty. All the offal goes to the rendering tanks. No inspection is made of the meat prepared at this place. Those who slaughter kill what they please and peddle the meat.

*Fitchburg.*

79. At the end of a rendering plant, which is not being conducted as such at present, is a room 20 by 12 feet, used for killing and skinning horses. It has a sloping floor, with a gutter in the centre, and the floor is washed. The rest of the place is very dirty, and on the day when visited there was a horse's carcass hanging up, covered with flies and vermin.

80. Slaughterhouse, 25 by 15 feet, in the end of a barn. The floor contains a trap door communicating with a cellar, where hogs are kept. The offal is pushed through a trap door. About 100 calves, 40 cows and 12 hogs per month are killed. A rendering company collects bones and hides twice per week. Floor, walls and the whole place are very

filthy, and show no evidence whatever of any cleaning. The nearest source of water supply is in a barn seventy-five feet away. The local inspector is notified by telephone when slaughtering is done.

### *Gloucester.*

81. Slaughtering is carried on in a compartment, 25 by 30 feet, of a barn. The killing floor is rough and broken in places. There is a cellar beneath, where hogs dispose of whatever offal is thrown down. The floor and the walls appear to have received no cleaning. The whole place is very dirty, and swill is scattered all over the premises.

82. Slaughterhouse is an isolated building, 20 by 30 feet, which appears not to have been used much in summer. The floor is dirty and so are the walls. What drainage there is goes to a stagnant pool among rocks near by. A considerable number of calves are killed in the course of the year, but on the day of visit no business was going on.

### *Granby.*

83. A small shed, 18 by 12 feet, adjoining the barn, is used as a slaughterhouse by butchers from Holyoke. About 4 to 6 animals are killed each week. Offal goes to hogs beneath. The place is very dirty, and apparently no cleaning is done.

84. Calves are slaughtered in a space 14 by 18 feet, in a barn. The offal goes to hogs beneath, and is covered every few days with sand. In winter the meat is sold to neighbors; in summer it is sold in bulk. Occasionally a horse is killed here for the hide. The floor is not properly cleaned.

85. A shed, 18 by 20 feet, in a pasture, is used as a slaughterhouse, chiefly by butchers from Holyoke. Six to 10 cattle are killed each week, and from time to time a few calves. The place was built for slaughtering purposes and has a refrigerator connected, but no ice is used. The floor is somewhat worn and has not been kept clean, but it is better than the average. The offal is fed to hogs beneath. There is a small ventilator in the roof, and a steam heater to provide hot water.

### *Great Barrington.*

86. Slaughterhouse is a small building, 20 by 30 feet, in a field a mile from the town. Here 20 to 30 lambs and calves are killed each month. The hoofs, bones and heads are sold. Water is pumped from a well underneath. The floor is cleaned in the centre, but elsewhere it is dirty, as are also the walls and benches. The offal is given to hogs in an adjoining pen, which is kept in fair condition.

*Greenfield.*

87. Slaughterhouse, 25 by 40 feet, situated in the woods about two miles from town. A dozen or more lambs and a variable number of cows and calves are killed each week in the busy season. There is a refrigerator on the same floor.

Fat, bones, offal, etc., go into the rendering tank, and the oil is sold. The tank liquor is carted away and deposited in the fields. The tank residue is pressed dry and sold for fertilizer. The bones are dried on the floor of a separate building and sold for glue stock. The rendering is done in a building adjoining the slaughterhouse. The floor and all parts of the slaughterhouse are very dirty, and apparently no cleaning is done. The premises in general are very dirty. Most of the meat goes to local butchers.

*Hampden.*

88. Shed, 12 by 18 feet, used as a slaughterhouse for calves, poultry, etc. A portion is partitioned off and used as a pen for animals awaiting slaughter. The offal is carried away. Slaked lime is strewn over the floor, which, however, is not very clean.

89. From 10 to 12 calves per week are slaughtered on a portion of the barn floor, 10 by 12 feet. The offal is given to hogs in the cellar beneath. Water for cleaning has to be brought in. The floor is in poor condition. The general condition is dirty.

*Hanson.*

90. About 10 cows and 10 calves per month are killed on the barn floor, 12 by 20 feet. The cow and horse stalls are immediately adjacent. The offal is buried on the farm. The heads, etc., are sold. The floor is covered with hay and dirt, but at the time of visit there was not much evidence of the slaughtering business.

91. About 300 hogs per year are killed in the building, 12 by 30 feet, which is in fair condition. At the time of visit the floor was strewn with lime and the place was fairly clean.

*Harvard.*

92. Slaughterhouse a part of a good barn, one-eighth of a mile from the centre of the town. The space used for slaughtering purposes is 20 by 35 feet; the rest of the building is used for stalls and calf pens. In the centre of the killing floor is a trap door communicating with a dirty cellar, where the offal is given to hogs. The floor is cleaned to some extent in the centre by means of an old broom, but the rest of

the floor and the walls are thickly covered with blood and manure. The place is infested with flies and has a disagreeable odor. About 70 calves per month are killed, the meat of which, after inspection and stamping, is sent to Boston.

93. A portion of one end of a large new barn, in the centre of the town. The slaughtering floor is 20 by 30 feet, with a trap door in the centre. The cellar beneath is large, and only one corner is used for manure. The blood, water, etc., are washed into this portion. The offal is buried in the fields. Hoofs and heads are sold.

The cooling room, 10 by 12 feet, and the refrigerator of the same size were empty at the time of visit and in clean condition.

Fifty calves and about a dozen cattle are killed each month, and during the course of the year about 150 hogs. When sent for, the inspector comes as a rule, but occasionally fails to appear, in which case the meat is sent to Ayer. Most of the meat is sent to Boston.

The centre of the floor is washed, but the walls, doors, etc., are left somewhat dirty. The place, as a whole, is in fair condition.

*Haverhill.*

94. Slaughtering is done in one end of a barn, which, at the time of visit, was filled with hay and appeared not to have been used for some time. A variable number of calves (not over 50 a year) are said to be killed. The surroundings and general character of the place are good.

95. Slaughtering floor, 12 by 28 feet, connected with a barn. It has a loose board floor, beneath which is a shallow cellar. At the time of visit, the place was in fairly clean condition, and showed no evidence of recent use. About 500 hogs and calves are killed between October and April.

96. Part of a large old building in a field about a quarter of a mile from the road and dwelling houses, originally used as a piggery. One end is partitioned off for slaughtering. The floor, 25 by 25 feet, slopes slightly to one side, where the offal is pushed out of a small opening into a box, and this is carted off and fed to pigs elsewhere. The slaughtering floor is scraped fairly clean, but the walls are not cleaned at all and are very dirty. There is an ice-box, 8 by 15 feet, opening into the slaughtering room, but it is not used. From 12 to 15 cows and calves per week are killed.

*Holliston.*

97. From 20 to 30 calves and cows per month are killed in an annex, 28 by 18 feet, to a barn; in the autumn and winter hogs are also killed. The slaughterhouse has a fairly good floor, which was found to be clean, but the walls and utensils were dirty. The offal is used in part to feed

swine and part of it is buried on the farm. Water is brought in pails from the well as needed. On the day of visit no slaughtering was being done.

*Holyoke.*

98. Building, 12 by 20 feet, in a field half a mile from house, used by various butchers for killing 12 to 40 cows and calves per month. The offal is given to hogs in the cellar beneath. Water is obtained from a brook one hundred yards away, but none is used for cleaning purposes, and the floor and walls are dirty, and the whole place and vicinity give off a disagreeable odor.

*Hubbardston.*

99. From 20 to 40 cows, calves and sheep per month are killed on the barn floor. The work is done in a neat manner, and the place shows very little evidence of business, for sawdust and lime are used on the floor and the blood is not spattered about. The offal is given to hogs in a pen outside.

100. Ten to 20 calves per month are killed on the barn floor, which shows little signs of blood or dirt. The blood is caught in a bucket and the offal is removed.

101. The killing floor, 12 by 12 feet, is partitioned off in a corner of the barn. It has a trap door to the cellar, where hogs are kept. The floor is covered thickly with sawdust. About 20 calves per month are said to be slaughtered. The offal is fed to the hogs. Most of the meat goes to Gardner.

102. Building, 20 by 24 feet, with good sloping floor, with a hole at one end through which the offal is pushed. Only an occasional cow or calf is slaughtered. Cleaning up in the past has not been thorough, and old blood and dirt remain on the floor and walls. What water is used comes from a well seventy-five feet away. Very little business had been done for three months preceding the day of inspection, by reason of the fact that competitors had been buying up the very young calves.

103. Part of an annex to barn, 40 by 30 feet, is used as a slaughter-house. The floor is dirty and slippery with blood and dirt mixed with lime. Considerable stinking offal was lying about on the day of inspection. From 20 to 40 calves and cows are killed each month. Some of the offal is fed to hogs and some is buried.

*Hudson.*

104. Building, 25 by 35 feet, on the bank of a river; has not been used for slaughtering purposes for more than a year, though a license is held. The place is now used for melting grease. The floor is much worn, but has been washed. The tables, utensils and refrigerator are dirty. In the cellar beneath is a decomposing mass of offal, old blood, manure and slimy material, which gives off foul odors.

105. Slaughterhouse, built in a corner of a new barn, covers an area 12 by 15 feet. It has a trap door in the centre. The cellar beneath is fairly clean. The place had been used but little at the time of inspection, but appeared to have been kept clean. About 10 calves per month and 25 hogs per year are slaughtered, and the inspector calls and stamps the meat. A rendering company takes the hides and bones. The offal is given to hogs.

*Lanesborough.*

106. A wooden building, 28 by 50 feet, is used as a market, refrigerator, sausage and lard room, and slaughterhouse. It is divided into three rooms, one of which, 28 by 15 feet, has a wooden floor with a trap door in the centre, under which are a box of sand and a bucket for catching blood. The blood and offal are given to hogs under a barn one hundred feet away. The killing floor is strewn with lime, and little evidence of spattering of blood is observable. The business appears to be conducted in a neat manner. Thirty or more calves per month are killed.

The lard and sausage business is carried on only in cold weather. The material used in this part of the business is brought by farmers who kill their own hogs.

*Lee.*

107. Building, 24 by 12 feet, used until March last for killing calves, cows and lambs, no business being conducted since then. The floor slopes to the rear. When used, the offal was pushed out of a door in the back and carted away.

108. Building, 20 by 20 feet, in a field a mile from the town. It has a rough floor with a trap door, through which the offal goes to a platform in the cellar, where hogs are fed. The cellar is wet and dirty. About 20 to 30 calves and sheep per month are killed. There is running water, and the floor shows evidence of occasional use thereof, but the doors and walls are covered with blood and dirt. Hoofs, heads and bones are sold. The premises in general are rather dirty.

109. Wooden building, 16 by 18 feet, in a field. It has a rough floor,

and a hole at one side through which the offal is delivered to hogs. The surface water and drainage from the slaughterhouse gather in a hole in the pigpen behind, and form a green, foul-smelling pond fifty feet in diameter.

Thirty to 40 sheep, calves and cows per month are killed. Only a small place on the floor is cleaned; the rest remains dirty and bloody. What water is used is brought in a pail from a spring. Adjoining are several cattle pens.

110. Forty calves and a few cows and lambs are killed each month on the barn floor. The offal goes out of the back door to hogs. Hoofs and heads are sold to the collectors of a rendering company. There is no evidence of cleaning, and the floor and walls are bloody and dirty.

### *Lenox.*

111. Building, 24 feet square, on the edge of a meadow. Twenty calves per week and about 200 hogs per year are slaughtered. In a side room, 10 by 12 feet, there is a kettle for heating water. A hose supplied with town water is used for cleaning the floor, which is in good condition, but the walls show dried blood stains. The floor has a slight pitch, and the offal is pushed out of the small opening at one side into a hogpen, where it decomposes and produces a bad odor, which is perceptible for some distance. The meat is sold in a market in Lenox.

112. About 5 cows and 25 to 40 calves per month are killed in a small shed 17 by 10 feet, on the river bank. The floor has a slight pitch, and the offal is discharged into a hogpen adjoining, where it is mixed with earth and manure. The floor is clean; the walls are bloody and stained. Washing is done with river water obtained with a bucket. There is but slight odor.

113. Slaughterhouse, 24 by 18 feet, adjoins the barn. About 50 calves, 30 sheep and lambs, and 35 to 40 cows are killed per month. The refrigerator, 24 by 18 feet, opens from the slaughtering room and is fairly clean. The floor has a slight pitch, and is provided with gutters, through which blood, water and offal are shoved along into a hogpen adjoining. The water supply comes through a pipe from the hills above, and the place is washed with bucket and broom. It appears that in the past the cleaning has not been thorough, for the floor and walls are considerably stained; but of late considerable improvement has occurred. Some alterations, including a cement floor, are being considered. The conditions inside may be described as fairly good.

*Leominster.*

114. Building in a field, with slaughtering floor 25 by 30 feet. Refrigerator in the corner, 6 by 12 feet. The floor of the slaughtering room pitches to a gutter in the centre. Offal is pushed out of a hole in the wall into a hogpen. Fifteen to 25 cows and 50 to 100 calves are killed per month. Water is obtained from a brook by means of a bucket. The refrigerator is dirty. The floor, walls, doors, benches and all utensils in the killing room are exceedingly filthy, and a foul odor is noticeable everywhere.

*Lexington.*

115. Portion of small barn, 20 by 18 feet, used for slaughtering; has a rough dirty floor covered with shavings, which are used also for bedding for horses in the adjoining stalls. Pieces of harness and a lot of old dirty burlap, some knives and other butchering implements scattered about. The walls and floor are covered with clotted blood, dried manure and dirt. Water is obtained, as needed, from a well. The offal is thrown out of the only window to hogs in a small, dirty pen. Some of the offal is said to be buried on the place; and hides, hoofs and heads are carted out and sold to a rendering company. From 30 to 40 calves per month are slaughtered, and the meat is sent to a commission house in Boston. On the day of inspection 8 small calves, from one to two weeks old, were confined in a pen, and were to be killed that day.

116. Combination slaughterhouse and piggery. About 100 pigs are kept in pens and are fed on garbage. Decomposing garbage, giving off extremely nauseous odors, was observed strewn about generally. Slaughtering is done in a building 12 by 28 feet. It had recently been whitewashed, the whitewash being applied over the accumulated dirt. The place in general is very dirty. Water is derived from a well in the yard. From 20 to 40 calves per month are slaughtered, and a large number of hogs — more than 1,000 — per year, for hotels in Boston. Much of the offal is said to be buried on the farm, and some is sold.

117. Slaughterhouse, 20 by 15 feet, is a shed at the end of a dwelling house. It has a rough earth and cement floor, upon which ashes and dirt are sprinkled to cover up blood, etc. It is used not only for slaughtering of calves, but as a hen-roost, and considerable hen manure was observed. The water supply is derived from a well in the yard.

118. Slaughtering is done on a platform, 12 by 15 feet, on the floor of a fairly clean barn. The place is whitewashed and lime is used on the floor. Twenty to 30 calves are killed per month. The hides, hoofs and

heads are sent to a rendering establishment, and the offal is fed in part to pigs kept in pens some distance away, and in part is buried on the farm. A fairly clean place.

119. On the floor of a small barn, 12 by 20 feet, some butchering of calves is done without a license. On the day of visit no other information was obtainable. The floor and walls were covered with clotted blood, dirt and hair. The offal, mixed with manure, was stacked up outside the barn.

*Longmeadow.*

120. Shed, 15 by 30 feet, in a field. Six to 10 calves per week are killed, and the offal is thrown to hogs in a pen adjoining. In cool weather a few cows and hogs are slaughtered. Water is brought in cans for the purpose of cleaning the floor, which, however, is dirty and smells badly.

*Ludlow.*

121. From 6 to 10 calves per week are killed on the floor of a dirty cow barn. Hogs are kept in a dark pen beneath, and to them are given the blood and offal.

*Lynn.*

122. A number of dilapidated sheds, barns and out-houses, in dirty condition. Thirty or 40 hogs and a number of dogs were roaming at will on the day of visit. The slaughterhouse itself is part of one end of a barn, 25 by 30 feet. It contained dirty harnesses and tools, grain in barrels, blankets and old bags, and about a dozen cow and calf skins folded, ready for removal. The cellar underneath was filled to a depth of two or three feet with slimy material and manure. The place is exceedingly dirty in every part. A large number of animals are killed weekly.

123. Small slaughtering establishment, in which hogs are killed between October and March. When visited, the place was fairly clean, but had not been used for five months.

*Lynnfield.*

124. Part of an old barn; slaughtering area, 20 by 25 feet. On the day of visit a hurried job of whitewashing had been done, the whitewash having been applied over the dirt, and to the ropes, wheels and elsewhere where not needed. The place in general is dirty and dilapidated. The blood and offal are sent through a trap door to the cellar, which drains into an unused well. About 10 cows and calves per week are killed; hogs are killed in the autumn.

*Marlborough.*

125. About 25 calves and 2 or 3 cows per week are slaughtered on a portion of a barn floor, 12 by 24 feet, which is covered with loose boards. There is a refrigerator, 12 by 18 feet, which on the day of inspection was empty. In an adjoining section of the barn, separated by a partition and doors, a few horses are killed, and in the winter season about 300 hogs. This place had not been used for some time. Beneath the former section is a cellar, wherein are confined hogs to which the blood and offal are given. The whole place and surroundings are dirty, and the barn is foul smelling.

*Medfield.*

126. Four or 5 calves are killed per month in a room, 20 by 28 feet, in the rear of a provision store. The floor slants to one side, and the blood and offal are caught in a pail and given to pigs in a pen farther back in the yard. There is no evidence of recent use, and the place appears to be kept in a cleanly manner.

*Medway.*

127. When visited, this place had no license. In a dark shed, 12 by 15 feet, were the carcasses of several calves, which were being skinned and dressed on the ground, there being no floor. A new building, 12 by 15 feet, in a field adjoining, has a rough cement floor, covered with dirt and blood. On the walls hind quarters, lungs, livers, hearts, etc., were hanging about, swarming with flies. In a crate in the yard were 6 calves awaiting slaughter, and 2 of them were unusually small and lean. The whole place was very dirty and in disorder. Twenty-five cows and a much larger number of calves are said to be killed monthly.

*Merrimac.*

128. Space, 12 by 18 feet, on barn floor used for killing calves and occasionally cows. A trap door in the floor communicates with the cellar below, in which are kept hogs, to which is fed the offal. The refrigerator, 6 by 9 feet, opens from the barn floor. It is clean but not in use. The slaughtering floor and the walls are bloodstained and dirty, and littered with feathers from recently dressed poultry. In winter, hogs are brought to this place after being slaughtered on farms, and are dressed in an outhouse, 12 by 30 feet, where pork, hams and bacon are cured, sausages are made and lard is rendered. This building was found to be in fairly clean condition.

*Methuen.*

129. A part of a barn floor, 35 by 15 feet, is used for slaughtering. It has a slit and a trap door, through which the waste products go to the cellar, where they are eaten by hogs. This cellar is full of slimy matter and manure. The refrigerator, 12 by 15 feet, fairly clean, was well filled with meat. The water supply is derived from a well in the yard, and what water is used for washing is brought in. From 25 to 30 cows and 40 calves are killed each month. While awaiting slaughter, they are kept in stalls on the same floor. The heads, hides and hoofs are carried away by a rendering company. The whole place is very dirty. The floors and walls are thickly encrusted with blood and dirt. There is no evidence of any cleaning.

130. Slaughtering done in a filthy old barn, on a floor, 20 by 25 feet, with a slight slope. In the centre is a slit for the blood, and in the rear, a door through which the offal is sent to the ground outside, which is covered to a depth of a foot or more with slimy manure and refuse, which drain back into a field. There is an unused refrigerator, 20 by 15 feet. The place is in constant use, and from 20 to 50 cows and calves are killed per month. On the day of inspection a place in the centre of the floor, about 6 feet in diameter, had been washed, but everywhere else were dirt, filth, slime, grease and flies.

131. Slaughtering room, 25 by 15 feet, with a rough wooden floor, in which is a trap door. Beneath is a cellar where hogs are kept. There is a refrigerator, 10 by 12 feet, which on the day of inspection was empty. Twenty-five animals per month is the average number slaughtered, exclusive of hogs, which are killed in the autumn and winter. Next to the slaughtering floor is the cow tie-up, 25 by 20 feet. Heads, hides, hoofs, etc., are removed by a rendering company. The offal is thrown into the cellar to the hogs. Here the admixture of loam to the manure, etc., makes the condition less offensive. The whole place was found to be very dirty, and showed no evidence of regular cleaning.

132. The slaughterhouse, 30 by 40 feet, is one of a collection of sheds in the woods. On the day of visit it was locked, and admittance could not be gained. Hogs were observed in a dark, wet cellar beneath. There was a foul odor about the premises, and what could be seen was dirty, and there was no evidence that cleaning is ever done. From 20 to 40 cows and calves are killed each month.

*Middleborough.*

133. About 400 hogs and 50 cows per year, and 30 calves per month are killed on a barn floor, 25 by 10 feet. The water supply is derived from a well in the yard. Close by are cow stalls and hay. A trap door communicates with a fairly clean cellar, in which no hogs are kept. The offal is buried on the farm in summer. Heads and hoofs are sold in cold weather. While the place appeared to be rather dirty, the work is much more neatly done than in some other places, and there was a smaller accumulation of blood and dirt. The place was infested with flies, and 2 dressed calves, hanging in the barn, were covered with them.

*Milford.*

134. The slaughtering room is partitioned off in the end of a very good barn. Beneath is a cellar, in which hogs are kept in summer only. From 45 to 55 cows and calves per month are killed. The offal and blood are collected in tubs and buried in the summer months, and mixed with manure in the cellar in the winter. In another building is a market, in which is situated the refrigerator. In another small building sausages are made in cold weather. There is running water in the barn close to the slaughterhouse. On the day of inspection the place was found to be fairly clean, the walls having recently been scraped quite free from blood, etc. The refrigerator and market were found to be in good condition.

*Montague.*

135. Building, 20 by 30 feet, in a field a quarter of a mile from dwelling house. In one corner a refrigerator, 12 by 6 feet, passably clean. Next to the slaughtering floor are two cow stalls and a pen for calves; in another corner a place where hides are salted and piled. Underneath is a cellar with hogs, which feed upon the offal. The slaughtering floor, tables, walls, doors, etc., are very filthy, and appear to get no cleaning whatever. Some water is collected in a barrel from the ice which melts in the refrigerator, but it is not used on the floor. From 50 to 75 cows and calves are slaughtered.

*New Bedford.*

136. Slaughterhouse is a room, 11 by 15 feet, in a building which is one of a collection of stables, sheds, etc., on the outskirts of the city. The floor is rough and uneven, and although it is washed with a hose it cannot be thoroughly cleaned. The walls and benches are spattered with blood and dirt, and appear not to be included in the operation of cleaning. Ten to 15 cows and a larger number of calves are killed each month. All offal and refuse are removed by a soap company. The

meat is carried to a store near by and put into cold storage. This establishment was fairly clean.

Condemned cattle are killed here in considerable numbers and delivered to the soap company, which gives a receipt for the carcasses, and the receipts are given to the inspector of animals.

*Newburyport.*

137. In a shed 16 by 20 feet from 15 to 20 calves and several dozen chickens are killed each month, and in winter there is some slaughtering of hogs. The veal is sold to the local markets. The place is dirty and untidy, although it is said to be cleaned after each killing. The hides, bones, etc., are taken away by a rendering company.

138. Small building in a field, with a small yard from which cattle are led through a stall to the killing floor, which is 20 by 30 feet. The blood and offal go through a trap door to a cellar, where they are covered, once a week or oftener, with sand or dry leaves. Bones, fat, hoofs, hides, etc., and the carcasses of condemned horses and cows are sent to a rendering plant in metallic barrels. The meat is cooled and then hung in the refrigerator, 10 by 12 feet. Some "barrel meat," consisting of trimmings and small irregular pieces, is sold to sausage makers. The floor of the slaughterhouse is rough and uneven, and though said to be cleaned every night is very dirty. The walls also are very dirty and are apparently never cleaned. The place is infested with flies and has a foul odor.

*North Adams.*

139. In an old building, in which there is a room 20 by 30 feet, with a rough wooden floor, about 20 to 30 cows and calves are killed monthly by different butchers. There is running water from the hill, but the place is cleaned only with a broom, and is dirty. Offal is thrown into a hogpen adjoining. Bones and hides are sold.

140. On a hill in the outskirts of the city is a large hogpen, near which is a building 25 by 45 feet, which is used as a slaughterhouse. The killing room, 25 by 30 feet, has a rough wooden floor. The offal is pushed out onto the ground and left in a decomposing, stinking heap. Although there is running water at hand, no cleaning is done. An uncertain number of cows, probably between 20 and 40, are killed each month by different butchers. The place is very dirty and foul smelling.

*Northampton.*

141. A small building in a field; rented to a number of butchers. Fifteen to 30 cows and calves are slaughtered each month. The board floor slopes slightly and is washed clean. In the middle of the floor

is a trap door, and at the end is a slit through which the blood escapes. All offal is sent into a shallow cellar or into a ditch behind, from which it is removed from time to time and buried. The water supply is derived from a well close to the door. There is an ice-box 5 by 10 feet, but it is not used. Although the floor is clean and well kept, the walls are not cleaned, and considerable blood, etc., was observed.

*Norwell.*

142. Slaughterhouse, 10 by 25 feet, in the end of a dilapidated barn. The floor, walls and doors are very dirty. About 175 hogs and 25 calves are killed per year. The offal is given to hogs in a pen outside. When visited, there was no evidence of recent use.

143. Ten to 20 calves per month are killed back of the horse stalls on the floor of an old barn. The slaughtering is confined to the spring months. The offal is carted off and buried. On the day of inspection the place was found to be in a properly clean condition.

144. Thirty or 40 calves per year are killed in a shed 12 by 20 feet. There is no cellar. The offal is buried on the farm. On the day of visit there was no evidence of recent work, and the place was in fairly clean condition.

145. Slaughterhouse, built twenty-five years ago, contains two large refrigerators. The killing floor, 28 by 14 feet, has communication by means of a trap door with the cellar, into which offal was formerly discharged. Although this practice has been discontinued, a slimy, stinking mass of offal was found still being stored. About 100 calves, 20 sheep and 5 cows are said to be killed during the course of a year. The place, in general, is dirty, and infested with flies.

*Palmer.*

146. Part of a barn four miles from town, made into a slaughterhouse; two large refrigerators, 15 by 15 feet, not much used. Main slaughtering floor, 30 by 15 feet, has a good slope, and is made of smooth boards. At one end is a hole, through which offal is discharged to hogs in a pen outside. From 2 to 4 cows, 3 to 6 calves, and a few sheep are killed each week. Some rendering of tallow is done in a building in the yard. The heads are boiled and the bones are sold. On day of inspection the walls had been scraped clean, and the floor showed evidence of constant cleaning with water from a cistern.

*Peabody.*

147. Building, 22 by 22 feet, adjoining a barn close to a dwelling house. The floor pitches slightly to a slit about four feet long and an inch in width, through which the blood, and water used in cleaning, run

to the cellar beneath, where sawdust is used for their absorption. The fat, heads, hoofs, etc., are sold to renderers. The offal is buried on the farm. The place shows evidence of constant care. It is whitewashed, and the floor is very clean. Sulpho-naphthol solution is sprayed on the floor after each killing.

*Pembroke.*

148. From 75 to 100 calves and a dozen cows are killed in the course of a year in the end of a new barn. The slaughtering is done close to the horse stalls, where there is a trap door. Before killing begins, sawdust is spread upon the floor for the purpose of absorbing blood, and later it is thrown into the manure cellar. There is no spattering of blood, and the place is clean.

149. An old blacksmith shop, 20 by 28 feet, used as a slaughterhouse, chiefly in cold weather. About 100 calves are killed in the course of a year and some hogs in winter. The inspector is sent for when there appears to be anything wrong with the meat, whereupon he decides whether or not it is fit for food.

150. About 50 hogs and an inconsiderable number of calves are killed during the course of the year in a corner of the barn. When inspected there was no evidence of recent use. An inspector is sent for to stamp the meat.

*Pittsfield.*

151. Slaughterhouse is a room, 20 by 25 feet, next to the barn. It has a fairly good board floor, washed clean. Walls and doors spattered with blood. Place said to be washed after each killing. Floor slopes to the rear, and the offal is discharged into a fairly dry and clean hogpen outside. During the summer, only about 10 calves per month are killed. The heads and bones are boiled. Conditions much cleaner than ordinarily observed in small slaughterhouses.

152. This place is known as ——'s slaughterhouse, and six different individuals have licenses to kill here. Slaughtering is carried on in a space 25 by 30 feet, with a cellar beneath. The water supply is derived from a well and a brook. From 40 to 60 cows and calves are killed each month. The offal is given to hogs. The bones and heads are sold. On the day of inspection the place appeared to have recently been cleaned, but the walls, floors and doors showed evidence of having gone uncleaned for a long time.

153. Building, 20 by 35 feet, in a field near a meadow. The killing floor has a gutter in the centre for blood. In the wall is a hole, through which to push out the offal, which is collected in tubs and removed. The place is dirty and foul smelling. No information could be obtained as to the number of animals slaughtered.

*Plymouth.*

154. About 25 animals per month are killed in a building 22 by 28 feet, on the outskirts of the town. The cellar contains manure and some bones and offal. No hogs are kept and most of the offal is carted away. The place has no water supply, and no cleaning is done. The floor, walls, doors, benches, and everything about the premises are very dirty.

155. A few calves and hogs, not over a dozen per year, are killed in the spring and fall months in the barn.

*Raynham.*

156. Shed, 16 by 16 feet, at the end of a dirty barn. Floor space, 16 by 16 feet, is separated by a fence from a pigpen. Manure is piled up on the floor, and the hogpen is full of slimy manure. From 20 to 40 cows and calves are killed per month, and the offal therefrom is thrown over the fence into the hogpen. No cleaning is done, and the place is very dirty.

*Reading.*

157. From a small, dirty yard, cattle are driven to a pen and thence into a slaughterhouse, 15 by 22 feet, with a wooden floor, in which is a trap door to the cellar beneath. The place is supplied with running water, but the floor, walls and ceiling show no evidence of its use. The floor is scraped and swept occasionally, but the place as a whole is very dirty. The cellar contains about two feet of liquid, slimy manure. A refrigerator, 10 by 12 feet, in fair condition, opens from the slaughtering room. From 30 to 60 animals are killed monthly. The offal is carted away and buried. The fat, heads, hoofs, etc., are sent to a rendering establishment.

*Rehoboth.*

158. Slaughterhouse, 25 by 30 feet, has a rough board floor, communicating by means of a trap door with a cellar, in which 4 hogs, fed on offal, exist in three feet of slushy manure. The water supply is derived from a well in the yard. Refrigerator, 10 by 12 feet, in the corner, empty and dirty. About 50 cows and 20 calves per month are killed by several butchers, who do no cleaning whatever. The walls, doors, utensils and floor are covered with blood, manure, hair and filth. Bones are collected by a rendering company. The meat goes to Providence. There is no inspection whatever, and the place is filthy.

*Rockland.*

159. Small shed, 8 by 12 feet, used for killing about 10 calves per month. The floor is washed a little in the centre, but the place is very dirty and foul smelling. Flies were numerous on the day of inspection. The offal is buried, and the heads and bones are sold.

160. From 10 to 15 calves per month during part of the year are slaughtered in a shed 12 by 16 feet. No cleaning is done, but lime is strewn on the floor. Outside is a hogpen into which the offal is thrown. The place is dirty.

*Rowley.*

161. Slaughterhouse in a barn. It has a good floor, with a trap door to the cellar, and has plastered walls. There is a refrigerator, 10 by 12 feet, filled with meat of all kinds. Twenty or more cows and calves per month are killed between October and May, and about 200 hogs in addition. In summer, the amount of slaughtering done is small. On the day of visit the place was dirty, and much decomposing scrap meat was lying about on the floor, benches, etc., which had a foul odor. Although there is running water in the barn, little is used in cleaning the slaughterhouse. An out-building, 20 by 45 feet, is used for curing pork and hams.

162. A few calves are killed each month on part of the barn floor, 12 by 25 feet. The offal is carried away and buried. Water is brought from a well in the yard, and the killing floor is kept fairly well washed. The sides and walls are not clean. The general condition of the place is fair.

163. In the rear end of a good barn is a room, 20 by 12 feet, in which about a dozen calves are killed per month and an occasional cow or sheep. Hogs are killed in the autumn and winter. The floor has a trap door to the cellar below, where hogs are kept and fed upon the offal. A refrigerator, 14 by 4 feet, is in fair condition. The water supply is derived from a well in the yard. When inspected the room was dirty, but showed no signs of recent use. The inspector of cattle is occasionally sent for when any question regarding the fitness of meat for food arises, but he does not come regularly.

*Sheffield.*

164. Killing done in a space 25 by 16 feet, next to horse stalls. During the season 10 to 20 calves and lambs are killed each month. The floor is of earth, and apparently little cleaning is done. The offal is carted away.

165. Slaughtering done on part of the floor of an old barn, 12 by 15 feet. In the corner is a hole, through which the offal is pushed to hogs.

Water is brought in a pail, and the place is rubbed with a broom, but the floor is not very clean and the walls are very dirty. About 30 calves per month are killed. In a shed were 3 calves, from three to six days old, awaiting slaughter.

166. Slaughtering done on a barn floor 20 by 40 feet. A few cows and about 12 calves per month are killed. The offal, heads and bones are thrown to hogs in a pen behind the barn. Little cleaning is done, but the work is performed in a fairly neat manner, so that the place is in reasonably clean condition. The ice chest, 5 by 8 feet, is clean.

*Sherborn.*

167. In a room, 10 by 30 feet, in a large old building, horses and condemned cattle are killed for hides and bones. The meat is cut off and buried. The offal goes to a cellar below and is covered with lime. The floors are badly worn, and are merely scraped clear of surface blood. The place smells distinctly foul and is infested with flies.

168. Slaughtering done in a part of the barn, 12 by 18 feet, which is separated from the rest of the barn by thin board partitions, and has a ventilator in the room. Within twenty feet are 4 horses and 5 cows. The place is very dirty, and does not appear to be cleaned at all. Offal is thrown into the manure yard, but some of it is given to pigs. From 200 to 300 calves and cows are killed in the course of the year. Not much is done in the summer months. A rendering company buys the heads, hides, etc.

*Somerville.*

169. An old slaughterhouse in course of repair; killing room, 20 by 26 feet. Floor of rough planks, sloping to a trough, which can be flushed with a hose, but on the day of inspection was dirty and bloody, and the walls were spattered with blood and filth. Offal is thrown onto a manure pile in the cellar, and that present on the day of inspection was several days old and very offensive. The place was generally untidy and foul smelling. In a small room, 14 by 8 feet, the carcasses are hung up to cool. The floor drains to a strainer and is filthy and bloody. The meat hooks are greasy and bloody, and the beams black and covered with grease and hair. The place was swarming with flies.

*Southampton.*

170. The slaughterhouse is an old barn, the floor of which is covered partly with zinc. Thirty to 40 cows and calves per month are slaughtered. The offal is fed to pigs kept in a neighboring field. The heads and hoofs are sold. On the day of inspection, offal was still lying on

the floor, none having been carried out since the last killing. The floor gets no cleaning, except what can be done with an old broom. Lime is sprinkled about from time to time.

*Southborough.*

171. Specially constructed building, with cement floors. The hogs are driven from pens into a small room, where they are caught and hoisted to a floor above; thence to the killing room, which has a cement floor draining to a pipe in the centre. After being bled, they go to a scalding tank and then to a table, where they are shaved. Next they are hung up and dressed, inspected by a United States inspector and sent into the coolers.

General conditions excellent. Ventilation and light adequate.

The hogpens are in a building 90 by 38 feet, provided with water pipes. The offal is carted away to rendering works.

*Stockbridge.*

172. Slaughtering done in a barn some distance from any house, on a floor 20 by 30 feet, covered thickly with clotted blood and manure, and a considerable number of decomposing heads, hoofs, bones, etc. The offal is said to be carted away. About 25 calves per month are killed, and the meat is peddled from carts. The inspector comes when sent for and stamps the meat. The odor of putrefying meat is perceptible for a long distance from the barn. There is no water supply, and no cleaning is attempted.

173. Slaughtering done in a barn near village, in a room 8 by 10 feet. About 25 calves per month is the average. There is a cellar below, in which are hogs which eat the offal. The killing room is fairly well cleaned with water from a hose, but considerable decomposing matter exists about the place, and there is a strong odor therefrom in the vicinity. The meat goes to market in Stockbridge.

*Taunton.*

174. Hog-killing house back of the barn, with a kettle and scalding tank and table. Area, 30 by 15 feet. Although this place is licensed, no business has been done for two or three years. In the autumn it is let for butchering calves and hogs. The building is dilapidated, and has not been cleaned for a long time.

175. A few pigs and an occasional calf are killed in the yard. No sign of slaughtering observed on the day of inspection.

176. Building, 40 by 20 feet, put up for slaughtering purposes, and fairly well built for the business. The water supply is derived from a well outside. There is a trap door in the centre of the killing room, communicating with a shallow cellar, in which only the blood of the animals is discharged. But little butchering is now done at this place, — only 6 to 8 calves per month. The inspector comes when sent for and stamps the meat.

Although the centre of the killing floor showed evidence of being recently washed, the walls were covered with old blood and dirt.

177. Slaughtering done in a barn on the outskirts of the town. The killing floor, which is of loose boards, is 11 by 9 feet. From 25 to 40 calves per month and an occasional cow are killed. The offal is pushed out of doors and afterward is buried. No cleaning is done, and the floors, walls and utensils were all found to be in a very dirty condition. On the day of inspection, 1 very small calf was being dressed and a still smaller one was tied outside. It was asserted that this was to be fattened before slaughter.

*Wakefield.*

178. Shed, 20 by 25 feet, in which hogs are killed. It has a cellar filled with loam, which is used for the absorption of blood and other liquids. About 100 hogs are killed during the season. The place is clean, and seems to be well suited to the business.

*Watertown.*

179. The slaughterhouse, 20 by 35 feet, is properly lighted and ventilated, has no odor, and is kept scrupulously neat and clean. The floor is wood over concrete, and slopes to a channel connected with the sewer. The animals killed here are calves and swine. The offal is taken at once to the abattoir at Brighton. The room in which the swine and calves' heads are scalded is neat and clean, as is also the ice chest which is used for storage.

*Wenham.*

180. Slaughtering done in one end of a barn, 22 by 30 feet. The blood and offal pass through a trap door into a wooden trough, which discharges into the cellar of another portion of the barn. A refrigerator, opening from the killing-room, is in fair condition; but the rest of the place — the floors, benches, tables, walls and ceiling — is exceedingly dirty, and apparently never cleaned. The loose materials are scraped from the floor, but the rest remain. The cellars are in a filthy condition. About 50 cattle are killed per month. The refuse is carted away by a rendering company.

*Westfield.*

181. Building, 20 by 14 feet, in rear of barn. Twelve to 16 calves per month slaughtered on a rough board floor, which communicates by means of a trap door with a cellar, in which hogs are kept. The cellar is wet and muddy. The water supply is derived from a brook near by, and although some water is used, the floor is not thoroughly cleaned, and the walls are not cleaned at all. Offal is given to the hogs.

*Westford.*

182. Space 25 feet square, in the end of a barn. Floor covered to a depth of several inches in places with a mixture of blood, manure, hair and grease. Walls and ceiling nearly as bad. No cleaning is done, and the place is very foul smelling. The cellar beneath the killing floor extends to a pigpen in the yard, and this is filled to a depth of over a foot with slimy material, manure and liquid matter, in which the pigs have difficulty in getting about. About 20 calves per week, and in winter some cows, are killed. Hoofs, heads, etc., are said to be carted away.

*West Newbury.*

183. Shed, 20 by 12 feet, used as a slaughterhouse, where 10 to 20 cattle are killed each week. The meat is supplied to local butchers and to a provision company in Haverhill. Although the place is said to be cleaned after using, it was found to be in very dirty condition, and everything covered with flies and foul smelling. The offal is carted away to a pigpen in the woods. Fat, bones, etc., are sold to a soap company in Haverhill.

*Weston.*

184. Room, 28 by 18 feet, with sloping floor, in a barn. The shallow cellar beneath is empty and dry. Twenty to 30 cattle and calves per month are killed. The blood goes into a box on the ground outside the killing room and thence is carted away and buried. The floor is thoroughly cleaned with water from a well, but the walls, tables and benches are not clean and are covered with clotted blood. The conditions in and about this house are better than the average, and the barn, as a whole, is fairly well cleaned. All of the meat is inspected before removal, and is inspected a second time by officials in Boston, to which city it goes.

*Westport.*

185. Calves killed in an annex of the barn; area, 20 by 20 feet. It has a fairly good floor, with a hole, through which any blood and offal go to the cellar. The floor is not cleaned, but it is sprinkled with sand which covers up the blood, etc., and the accumulation is carted out from time to time. About 20 calves per month are killed. The offal and bones go to the pigs in the cellar. The cellar is full of wet, slushy manure and portions of carcasses. The slaughterhouse itself is whitewashed and not in very bad condition.

186. Stone building put up many years ago for slaughtering purposes. It contains large refrigerators and closed pens, in which animals were formerly confined. The slaughtering room, 35 by 40 feet, is used by butchers from Fall River. It has a rough board floor, sloping to one end, where the offal is pushed out into the yard. The floor is not cleaned at all, and everything is bloody and dirty and covered with manure. Several barrels containing putrefying intestines, said to have been saved for sausage casings and then allowed to spoil, were observed. The offal is fed to swine.

187. Slaughtering carried on on the floor of the barn, which has a good cellar beneath, well lighted, of good height and fairly dry. All offal goes into this cellar, where it is fed to swine. The manure is mixed with cotton waste. On the day of inspection there were five good sized veal carcasses hung up to cool, and the place had been well washed, and but little staining of woodwork anywhere was seen. General condition excellent.

188. Only a few calves are killed on the floor of what is an ordinary cow barn. The floor is kept clean, and shows little evidence of the business.

*Westwood.*

189. Between November and March, about 100 hogs and a few calves are killed in a section of the barn which is used for the meat business all the year round. It is a clean and well-kept place, and shows no signs of the slaughtering industry. Meat carts, refrigerator, benches, etc., were found to be in a clean condition, and protected by burlap from flies. Under part of the building there is a cellar, in which 2 hogs are kept in the summer only. During the killing season the offal is carried away and buried. General conditions are excellent.

*Weymouth.*

190. About 25 calves per year are killed on a wagon-shed floor having an area of 20 by 30 feet. All refuse is disposed of. When slaughtering is carried on, the inspector comes and stamps the meat. The place is kept in clean condition, and shows little evidence of butchering. General conditions are excellent.

*Whately.*

191. Slaughterhouse, 15 by 15 feet, situated in a barn. This room, which is partitioned off and floored, beside being used for slaughtering, contains harnesses, tools and cattle feed. The animals slaughtered are calves and hogs. The offal is buried on the farm. Hides, hoofs, etc., are sold. The place is not very clean.

*Whitman.*

192. Slaughterhouse in a barn and wagon shed near village. The killing floor, 12 by 8 feet, slopes, and has two holes for the escape of blood and water, which go into troughs leading into the garden. From 10 to 20 calves per month and about 12 sheep, 12 hogs and 10 cattle per year are killed. The local inspector examines and stamps the meat. The offal is carted away and buried. The bones and heads are sold. The floor of the slaughterhouse is washed clean, and the place shows not much evidence of the butchering business. General conditions are excellent.

*Wilbraham.*

193. Building, 30 by 30 feet, with fairly good floor and a hole at one end, through which the offal is discharged to hogs in a pen outside. About 40 cows and calves per month are said to be slaughtered. Water is obtained from a well in the yard and the place is kept in a cleanly condition.

*Williamstown.*

194. Building, 25 by 50 feet, with room, 25 by 30 feet, which has a sloping floor and a wooden drain in the centre. About 25 calves per month and 250 cows per year are killed here. The offal is fed to hogs in the field. What water is used is brought from the brook in pails. The place is cleaned with a broom, but the floor and walls are covered with old blood and dirt. An inspector is sent for when needed. The place in general is dirty and foul smelling.

195. New building, about one-third of a mile from a dwelling house. Killing room, 22 by 12 feet. About 600 sheep, calves and cows are killed each month. Most of the meat goes to North Adams.

There is a small moveable platform, about 6 inches high, used to keep the carcasses from contact with the blood, etc., on the floor during the process of skinning and dressing. The water supply is derived from a driven well and is pumped into the room. A broom and bucket are used in cleaning up. The walls are not clean, and are covered half way to the ceiling on one side with clotted blood and dirt.

Hides are salted in the loft overhead, and the rest of the building, having an area of 22 by 28 feet, is used for cattle pens and refrigerator, — the latter 10 by 12 feet.

The offal is thrown into the hogpen from one side of the killing room. The heads and bones are boiled in a kettle outside and then given to hogs. The blood runs into a trough in the hogpen, where it is eaten.

In general, the conditions are fair, but the process of cleaning is not sufficiently thorough.

*Windsor.*

196. Slaughtering is done on a portion, 30 by 14 feet, of a barn floor. This has sawdust sprinkled over it to cover up the dirt and blood. From 16 to 25 sheep, calves and cows are killed here each month. Outside, in a dirty wet pen, hogs eat the offal. The heads are thrown into the bushes behind the barn, where they decompose and create a strong stench. Sometimes, on complaint of neighbors, lime is sprinkled about. The inspector calls and stamps the meat when sent for.

197. A few calves are killed in the corner of a horse stall. The place is pretty well cleaned up, and the offal is carted away and disposed of. There is a slaughterhouse over a mile away in a shed on a deserted farm. It has a floor, 20 by 14 feet, sloping to the centre to a wooden gutter. Offal and heads are scattered about the field in the vicinity for crows to eat. The surface of the floor is brushed off with the stump of a broom, but no other cleaning is done. There is no water supply. A number of animals, varying from 10 to 30 per month, according to the supply, are slaughtered here. Part of the meat is sent to Pittsfield.

*Worcester.*

198. One end of a barn, 50 by 20 feet, made over into a slaughterhouse, with a trap door to cellar below. No hogs are kept in the cellar, owing to objection by the board of health. About 100 cows and calves are slaughtered each month by different butchers. The inspector stamps the meat.

The place had recently been whitewashed. Whitewash is said to be used every week to cover up the dirt. The place is dirty and littered with scraps of viscera and other filth, and swarms with flies. When visited,

heads, bones, hides and a barrel full of putrefying intestines were standing, awaiting the wagon of a rendering company. Some of the offal is fed to hogs kept in a pen outside. The refrigerator, 35 by 12 feet, is in fair condition.

199. Slaughtering floor, 12 by 16 feet, in a building formerly used as a barn. Trap door opens to a cellar beneath. Hogs are kept outside. The centre of the floor shows recent washing and lime is used as a deodorant. A few old heads, bones and some offal were observed on the floor. Hides and hams are kept in side rooms. Refrigerator, 12 by 6 feet, was empty. Not much slaughtering is done at this place in summer, but in other seasons from 30 to 40 cows are killed each month, as well as a few calves and sheep. The water supply is derived from a spring outside. The offal is given to hogs or buried. When killing is done, an inspector is sent for. On the day of inspection the place was in fair condition.

200. End of a barn made into a good slaughterhouse, 25 by 30 feet, with a sloping floor to trap door in the centre. The cellar beneath has a stone and cement floor. Refrigerator, 10 by 12 feet, at time of visit was empty. From 20 to 30 calves and 15 cows per month are killed. After use, the floor is washed clean, and the premises in general are clean.

### *Worthington.*

201. Building, 20 by 16 feet, built of slabs. It has a rough wooden floor, with a hole on one side, through which offal is pushed out to hogs in the hogpen outside. In this pen is a foot of mud, and from time to time hay is thrown in to cover it. Hides are salted on the floor, which is cleaned a little with a broom and with water caught in a barrel when it rains. About 20 cows, 16 lambs and 10 calves are killed each month. The building is far from clean. The owner keeps a fairly clean market, and peddles meat from a wagon. The inspector is sent for when needed.

## Bakeries.

Chapter 75 of the Revised Laws (sections 28 to 34) requires that all buildings occupied as bakeries shall be properly drained and plumbed; shall be provided with proper wash rooms and water-closets, having ventilation apart from the bakeroom or rooms; and shall have, if required by the local board of health, an impermeable floor of cement or of tiles laid in cement, and an additional floor of wood properly saturated with linseed oil. It further requires that the walls and ceiling of a bakeroom shall be plastered or wainscotted, and, if required by the local board of health, shall be whitewashed once in three months; and that

the furniture and utensils shall be so arranged that they and the floor may at all times be kept clean and in sanitary condition. It requires also that the manufactured products shall be kept in perfectly dry and airy rooms, so arranged that the floors, shelves and all other facilities for storing the same can be easily and perfectly cleaned. It prohibits having a water-closet, earth-closet, privy or ash-pit within or communicating directly with the bakeroom of any bakery; and provides that sleeping places for employees shall be separate from the rooms in which flour or meal and food products are manufactured or stored.

Bakeries and confectionery and catering establishments, to the number of 547 were visited, in 25 cities and 3 towns. A study of the conditions observed led to the division of these establishments into four distinct classes, as follows: —

*Class A.* — Worthy of especial commendation.

*Class B.* — Satisfactory.

*Class C.* — Not especially bad.

*Class D.* — Distinctly bad.

Of Class D many are situated in badly lighted, unventilated basements, and some of them have water-closets either in the bakeroom itself, or so placed as to make the air thereof distinctly foul.

In order to warrant classification under A or B, the following conditions have been required: —

1. The situation of the room is not below the street level.

2. The size of the room is such that there is sufficient air space per capita.

3. Ventilation is adequate.

4. There are windows enough to secure good light. Artificial light is not needed during the daytime.

5. Everything is open, and easily inspected.

6. The floor is properly constructed, without large cracks.

7. The floor is clean (*i.e.*, reasonably clean during work hours, and always free from accumulated dirt).

8. The ceiling and walls are unbroken and clean.

9. Tables and troughs are clean, and so arranged (preferably portable) that the floor beneath may at all times be kept clean.

10. The sink and its surroundings and all shelves are clean, and free from decayed wood and decomposed vegetable matter.

11. The water-closet is neither in nor connected with the bakeroom and other rooms where food products are kept.

12. Employees do not use the bakeroom for a dressing room. Street clothes and underwear are not hung on bakeroom walls nor placed on the floors; neither are they laid on boxes nor within a closet in the bakeroom.

The following table, which was published in the "Monthly Bulletin" of the Board for August, 1906, shows the number of establishments examined in each place, and their classification: —

| Place. | Number visited. | A. | B. | C. | D. |
|---|---|---|---|---|---|
| Attleborough, | 4 | - | - | 3 | 1 |
| Boston, | 157 | 4 | 14 | 85 | 54 |
| Brockton, | 7 | - | 1 | 3 | 3 |
| Cambridge, | 41 | 1 | 6 | 18 | 16 |
| Chelsea, | 10 | - | 2 | 4 | 4 |
| Chicopee, | 6 | - | - | 2 | 4 |
| Clinton, | 8 | - | - | - | 8 |
| Fall River, | 20 | - | - | 7 | 13 |
| Fitchburg, | 10 | - | - | 3 | 7 |
| Framingham, | 4 | - | - | - | 4 |
| Gloucester, | 7 | - | - | 4 | 3 |
| Haverhill, | 4 | - | 1 | 1 | 2 |
| Holyoke, | 22 | - | 1 | 8 | 13 |
| Lawrence, | 28 | - | 1 | 12 | 15 |
| Lowell, | 35 | - | - | 10 | 25 |
| Lynn, | 23 | 1 | 1 | 11 | 10 |
| Malden, | 10 | - | 2 | 3 | 5 |
| Medford, | 4 | - | - | 2 | 2 |
| New Bedford, | 19 | - | - | 9 | 10 |
| Newburyport, | 15 | - | 2 | 3 | 10 |
| Quincy, | 5 | - | - | - | 5 |
| Salem, | 18 | 1 | 2 | 8 | 7 |
| Somerville, | 20 | - | - | 6 | 14 |
| Springfield, | 15 | 1 | 1 | 4 | 9 |
| Taunton, | 4 | 1 | - | 1 | 2 |
| Waltham, | 8 | 1 | 2 | 3 | 2 |
| Woburn, | 4 | - | - | 1 | 3 |
| Worcester, | 39 | 1 | 8 | 11 | 19 |
| Totals, | 547 | 11 | 44 | 222 | 270 |

Because of some doubt on the part of local inspectors as to what is meant by "distinctly bad" conditions, and because the standard upon which the above classification is based is more exacting than that called for by existing laws, a division of Class D is made, merely to separate the bakeries which were found to be clearly not in accordance with the

intent and meaning of the statutes from those concerning which reasonable doubt may arise.

In the new classification, basement bakerooms are considered alike with those otherwise located, and not so much stress is laid on certain points, *e.g.*, light and ventilation; hence, many of the rooms first placed in Class D fall into Class C. In addition, a list of all basement bakeries is given.

| Place. | Number visited. | A. | B. | C. | D.[1] | Basements. |
|---|---|---|---|---|---|---|
| Attleborough, | 4 | - | - | 4 | - | - |
| Boston, | 157 | 4 | 14 | 113 | 26 | 37 |
| Brockton, | 7 | - | 1 | 5 | 1 | 4 |
| Cambridge, | 41 | 1 | 6 | 19 | 15 | 3 |
| Chelsea, | 10 | - | 2 | 5 | 3 | 1 |
| Chicopee, | 6 | - | - | 5 | 1 | 4 |
| Clinton, | 8 | - | - | 4 | 4 | 6 |
| Fall River, | 20 | - | - | 12 | 8 | 3 |
| Fitchburg, | 10 | - | - | 5 | 5 | 5 |
| Framingham, | 4 | - | - | 3 | 1 | - |
| Gloucester, | 7 | - | - | 5 | 2 | 1 |
| Haverhill, | 4 | - | 1 | 2 | 1 | 1 |
| Holyoke, | 22 | - | 1 | 11 | 10 | 8 |
| Lawrence, | 28 | - | 1 | 20 | 7 | 3 |
| Lowell, | 35 | - | - | 24 | 11 | 11 |
| Lynn, | 23 | 1 | 1 | 13 | 8 | 6 |
| Malden, | 10 | - | 2 | 6 | 2 | 1 |
| Medford, | 4 | - | - | 4 | - | 1 |
| New Bedford, | 19 | - | - | 11 | 8 | 2 |
| Newburyport, | 15 | - | 2 | 6 | 7 | 5 |
| Quincy, | 5 | - | - | 1 | 4 | 4 |
| Salem, | 18 | 1 | 2 | 13 | 2 | 3 |
| Somerville, | 20 | - | - | 12 | 8 | 2 |
| Springfield, | 15 | 1 | 1 | 4 | 9 | 8 |
| Taunton, | 4 | 1 | - | 2 | 1 | - |
| Waltham, | 8 | 1 | 2 | 3 | 2 | - |
| Woburn, | 4 | - | - | 2 | 2 | 1 |
| Worcester, | 39 | 1 | 8 | 12 | 18 | 13 |
| Totals, | 547 | 11 | 44 | 326 | 166 | 132 |

[1] "D" refers here to establishments with conditions not in accordance with the statutes.

The object of the investigation was, however, not to determine the number of "passable" bakeries, but to ascertain the conditions under which baking and similar kinds of work are carried on, both with regard to the employees and the consumers.

Cellar air that is vitiated by respiration, by illuminating gas, kerosene, and the gas from coke or coal, is not fit for the employees to breathe; neither is a cellar a suitable place for handling flour, dough, jellies, cream, milk, etc., which go to make up food products, particularly on windy days in summer, when the sidewalk windows permit ready entrance of street dust into the chocolate and cream fillings or the lemon and apple pie fillings, as not infrequently has been observed.

The walls of a very large number of bakerooms were found to be more or less dirty and uninviting, and especially were those repellant with cobwebs and greasy and filthy shelves for dirty pans and trays. The walls of some had hanging upon them trousers, coats, vests, shoes, underwear and stockings.

Not a few neat-appearing salesrooms of bakeries were found to lead directly into baking rooms which contain not only water-closets but filthy sinks, and where street clothes and other wearing apparel hang on the walls or rest on the tables and other furniture. In many of them, it was observed, the employees chew tobacco, smoke and spit about promiscuously; and in one a baker was seen to spit within a short distance of loaves that were stacked on the floor.

The best conditions were found to obtain as well in the small "home bakery" as in the large modern establishments managed by corporations; and the poorest conditions were observed not alone in the smallest establishments. Bakeries worthy of especial commendation were noted in Boston, Cambridge, Lynn, Salem, Springfield, Taunton, Waltham and Worcester; and others with satisfactory conditions in Boston, Brockton, Cambridge, Chelsea, Haverhill, Holyoke, Lawrence, Lynn, Malden, Newburyport, Salem, Springfield, Taunton, Waltham and Worcester.

### *Examples of Bakeries with Commendable Conditions.*

#### *Boston.*

*A.* A small "home" bakery. The bakeroom is large, well lighted and ventilated, and is on the first floor. The water-closet is entirely separate. The whole place is exceedingly clean and neat.

*B.* A small bakery, employing 3 men. The bakeroom is new, and finely arranged as regards cleanliness and ease of cleaning. The light and ventilation are excellent. The water-closet is in an entirely separate part of the building.

*C.* A large bakery, employing 280 hands, who work in two shifts. The whole place is kept very neat and clean, and the rooms are light and well ventilated. The toilet rooms are separated from the rest of the bakery, and are ample. Great care is taken to have every part of the building in a cleanly condition.

*D.* A large bakery, well lighted and ventilated, and neat and clean throughout. A stone alley in the rear of the oven is provided for the removal of ashes, thus doing away with ash dust in the bakeroom. The toilet arrangements and metal clothes lockers are in the basement, away from the bakerooms, and are well ventilated.

*Cambridge.*

A building with ideal sanitary conditions, erected and equipped at great expense. Floors of stone, or cement covered with wood. Tiling readily washed. Rooms well whitened. Rooms well lighted (electricity for artificial lighting) and adequately ventilated. All departments clean and neat. Wash and toilet rooms in a separate part of building; separate porcelain sinks, with towels, for employees; metal lockers; stone floor; all conveniences modern; shower baths being constructed at time of visit. Employees not permitted to use tobacco while at work. Spitting not allowed in any of the rooms. Drivers of teams required to use gloves while driving, and to take them off when handling bread.

*Lynn.*

Second floor front room, 85 by 50 feet, exceptionally well lighted and ventilated. Distance from floor to ceiling 12½ feet. Eight windows. Floor well constructed, and clean. Tables and shelves covered with marble slabs and galvanized iron. Sink is of wood, and is away from partition, to prevent collection of dirt and filth in corners. Doughnut kettle well situated, and surroundings protected. Everything clean. The following notice is posted: "Please assist in keeping the wall and floor neat and clean." Toilet and wash rooms are situated far from the bakeroom, and the conditions in these departments are excellent.

*Salem.*

Large room, with store in front. Large store window. Ceiling plastered, clean and white. Sheathing from floor up to about 8 feet, then painted. Floor well constructed, and clean. Skylight window in front of oven, 8 by 5 feet. Clean galvanized iron in front of oven; clean floor under oven. Trough and tables clean underneath; troughs portable. Sink conditions admirable. Floor cleaned and scrubbed several times each week. Bakers clean and healthy appearing. Toilet room down stairs.

*Springfield.*

Room 175 by 60 feet. Twenty to 25 employees (day and night). Light good (three skylight monitors, about 8 by 10 feet; electric lights for night work). Ventilation good. Fire boxes in a back alley, thus preventing ash dust in the bakeroom in front of the oven. The well-laid maple wood floor is clean. Ceiling and sides of the room are sheathed. Height of ceiling, 16

or 18 feet. Tables movable. Sink and its surroundings clean. Four women keep the room in a cleanly condition. Doughnut room, separate from the bakeroom, 20 by 25 feet, is clean, light and pleasant.

### *Taunton.*

Room about 30 by 30 feet, well lighted and adequately ventilated. High ceiling, wood sheathed. Good (new) floor, and comparatively clean. Room well painted. Sink conditions good. Closets for storage of pans and food stuff in good sanitary condition. Trays said, and appeared, to be scraped and cleaned frequently. Every week two men give the room a thorough cleaning and scrubbing. A woman aids in daily cleaning. The room, furniture and utensils have every appearance of cleanliness.

### *Waltham.*

"Home" bakery with good light and ventilation. High-studded, clean room, covered with metallic sheathing. Good hard-pine floor. Oven rests on cement floor. Sink and surroundings clean. Water-closet upstairs, away from bakeroom.

### *Worcester.*

High-studded room, 40 by 80 feet, with large front windows; good light and ventilation. Ceiling and walls plastered and whitewashed. The hardwood floor is scrupulously clean; one person employed solely for scrubbing and cleaning. Sink conditions excellent. No spitting.

## *Examples of Bakeries with Objectionable Conditions.*

### *Boston.*

*A.* Iron sink in small side room smells as if it were used as a urinal, When the water-closet upstairs is used, the water backs up a little in this sink.

*B.* Bakeroom is used as a playroom by two children about two and four years old, and a cat is allowed to wander at will about the bakery, into the bread pans, etc. Waste is thrown in a heap under the oven.

*C.* Place is untidy, but not very dirty. Spitting on the floor is practiced. The bakeroom is separated from the stable by a single door. The horse's stall is used as a urinal.

*D.* Spitting on the floor was seen. Water-closet, next to bakeroom, is dark and dirty and apparently has no outside ventilation. The bakeroom floor is dirty.

*E.* The water-closet is dirty and offensive. It is a dark, unventilated closet, leading off the cellar stairs just outside the bakeroom door. As the door to the cellar stairs is frequently open, and is always so when entering the water-closet, there is a direct ventilation of the water-closet into the bakeroom.

*F.* Water-closet in small side room, which also contains the sink. The door leading to the water-closet is kept wide open, allowing the odors to enter the bakeroom.

*G.* Large bakeroom, with bad light and poor ventilation; gas used here even on brightest days. Floor dirty, and covered with ashes and coal dust. Spitting on floor by workmen. Mixing room with poor light and only fair ventilation.

*H.* Light fair in middle of room, but poor at sides. Ventilation fair. Cats are allowed free run. Considerable spitting on the floor. The water-closet opens directly off the bakeroom, and the door is kept open, allowing free ventilation into the bakery. The hand sink is in the water-closet, but the towel is kept in the bakery.

*I.* First floor room. Water-closet, filthy and offensive, is in a corner of the cellar used for storing stock. Bakeroom is dirty and untidy. The floor is dirty. Eggshells and other waste are thrown in a heap under the oven. Flour and other stock are stored in the cellar near the water-closet. The cellar floor is damp, and in one place there is a pool of water.

*J.* Basement bakeroom. Light fair. Ventilation fair. Water-closet opens practically off bakeroom, allowing ventilation into room. Aprons hang in water-closet. Baker smokes, and spits on floor.

*K.* Basement bakeroom. Light bad. Ventilation poor. Water-closet off an outside passage, and has a window to bakeroom, which can be opened. No light in water-closet, and no outside ventilation. Floor of water-closet is wet and nasty. Sink in the bakery is kept covered, and a bucket is used in its place. Bakers smoke while at work, and spit on floor. Place untidy.

### *Brockton.*

Light and ventilation fair. Floor in a nasty condition. Sink is nasty, as is also the water-closet in the corner of the bakeroom.

### *Cambridge.*

Room 25 by 70 feet. Light and ventilation fair. Sink and surroundings dirty. Beans and other food stuff thrown under oven among coal and ashes. Table and woodwork behind it very nasty.

### *Chelsea.*

Basement bakery, with poor light and no means of ventilation. Floor very dirty. Water-closet communicates directly with bakeroom, and is near flour and bread.

### *Clinton.*

Cellar with fair light and ventilation. Water-closet is practically in the bakeroom, and is in filthy condition. About a foot away stands an open barrel of flour.

### *Fall River.*

*A.* Rear room, badly ventilated, and so dark that three gas jets are required in the daytime. Water-closet is in the bakeroom, and the floor in its vicinity is exceedingly foul. The workmen spit about promiscuously. Sink conditions filthy.

*B.* Two rooms, badly lighted and ventilated. Trap of sink is stopped up, and drainage flows over the floor. Everything is filthy. Workingmen's clothes hang near bread troughs.

*Fitchburg.*

Cellar bakery, dark and unventilated. A very dirty place, with nasty shelves where bread is stored. Old clothes, towels, overalls, rubbers, etc., scattered about. Water-closet practically in the bakeroom.

*Gloucester.*

Cellar room, with fair light and ventilation. Under part of the floor is running water, said to be the overflow from a well. This is within three feet of a sink drain. Floor very nasty. Thick cobwebs, clothes, shoes and food material in close proximity.

*Holyoke.*

Room with very dirty windows and walls. Floor matted with dirt. Water-closet in the room. Pails of pie-filling near dirty clothing and shoes.

*Lawrence.*

Room dark and unventilated. Floor nasty. Conditions back of sink are filthy. Foul, dark, unventilated water-closet opens out of bakeroom.

*Lowell.*

Small, fairly lighted room, in the corner of which is a water-closet. Conditions about sink are filthy. Floor exceedingly dirty. Workmen smoke and spit promiscuously.

*Lynn.*

Cellar room, lighted by gas, and with no means of ventilation. Small sink, with nasty surroundings. Extremely offensive water-closet near by. All conditions absolutely bad. The shop upstairs has large windows, neat show cases and attractive display of products.

*Malden.*

An old room, poorly lighted and unventilated. Floor has large cracks and holes, containing food materials. Windows very dirty. Sheathing smoky. Shelves covered with dirt. Unclean conditions especially marked under the bread trough and back of and around sink.

*New Bedford.*

Dark and unventilated room, with water-closet opening out of corner. This closet is dark and filthy, and ventilates only into the bakeroom. The plastering is broken in several places. The trays are very dirty. The sink and surroundings are filthy. The ceiling is black.

*Newburyport.*

*A.* Room on street floor, 12 by 12 feet. Floor of boards laid on soil, with large cracks between. In the corner of another room is a sink, which receives the waste water from a sink in the story above. The collected organic matter in this sink gives rise to a very nauseating odor. The man in charge states that when "much stuff collects they shovel it out."

*B.* An old and very dirty room. Water-closet practically within the bakeroom. That part of the floor where ice cream is frozen is covered with dirt, which comes from ice, milk cans and other sources. There is a layer of accumulated filth from one-quarter to one-half inch in thickness. The scoops are kept in dirty water in an agate basin.

*C.* Basement room, very badly lighted by gas. Floor of concrete. Mixture of milk, eggs and sugar found standing in cans exposed to the cellar dust. Many flies observed floating in the mixture. A water-closet stands in the corner of the room. A short distance away and within two or three feet of the closet bowl is a large puddle of filthy water, due to the overflow from an obstructed drain.

*D.* Cellar very poorly lighted, by means of gas. Even with the gas lighted, it was impossible to see whether the cans and other utensils used were clean. The floor is partly cement and partly soil, and over a portion of it are loose boards, beneath which is an accumulation of stagnant water, which splashes between the cracks as one walks over them. General conditions exceedingly nasty.

*E.* Cellar room, with loose brick floor. Near the ice cream freezer, which is situated on the floor, is a gutter about five feet long, leading to a half-hogshead set into the ground in the corner. From the hogshead a pipe runs outside to the yard, but the pipe being plugged, the hogshead overflows. Near by is a window with a wire screen, and when the hogshead becomes full to overflowing, an employee dips the water out with a large pail and throws it through the screen, the network of which is in consequence partly obstructed with slime and filth.

*F.* Ice cream is made in a cellar having an area of 375 square feet. Over a portion of the soil floor are filthy boards. What light there is comes from two small windows. There is no ventilation. At the time of the visit a ten-gallon can was standing ready for a fresh mixture of milk and eggs, and it was said to have just been washed thoroughly with soap powder and hot water. On the bottom and sides of the can were thin layers of soft chocolate, which could be removed by rubbing with the fingers. Rewashing was advised, and the can was taken upstairs for that purpose; and it was noted that the water used for washing was not boiling, but was merely warm.

*Quincy.*

*A.* A small basement bakeroom, 25 by 20 feet, containing a bed with dirty bed clothes and filthy wearing apparel. Within a few feet of the oven and food materials is a dark, foul-smelling water-closet.

*B*. Basement room, 25 by 20 feet. Floor very dirty, and in places exceedingly nasty. Much smoke in the room. Ceiling very sooty. Employees chew tobacco and spit freely.

*Somerville.*

Rear room, with fair ventilation. Back of and around the sink the conditions are nasty. Water-closet leads out of and ventilates into bakeroom, the door standing open. Pails of pie-filling stand near the open water-closet door. Clothes closet in bakeroom, with door open.

*Springfield.*

Cellar room, 65 by 15 feet. Sink conditions filthy. Toilet and clothes room in a dark corner with door open, so that there is direct communication with the bakeroom. About six feet from the toilet room the following foods were found: milk, mincemeat, lemon and pastry. Under the oven were seen cans, paper, coal, dirt and accumulated food materials.

*Taunton.*

Distinctly bad conditions. Light fair. Ventilation fair. Shed in back yard with ash heap near. Low ceiling, smoky and very dirty. Stove funnel across dough table, covered with ashes and other dust. Eggshells, broken eggs, pasteboard and other clutter on floor. Wooden sink, very filthy, is boxed in underneath; its back and all parts are thoroughly nasty. Floor in front of sink nasty.

*Waltham.*

Fairly lighted and ventilated room, from one side of which a door leads directly into a room about 9 by 3½ feet. This door has no panel in the upper part, and was found wide open. The small room has two compartments, but the partition, in which is a door to the farther compartment, lacks several feet of reaching to the ceiling. One of these compartments, that nearest the bakeroom, is a dressing room, and the other is a water-closet. The whole place is dark and poorly arranged. This represents a not uncommon arrangement for water-closets, and raises the question whether the wording of the present law is sufficiently explicit. Some bakers claim that a toilet room thus placed is allowed by the present wording of the law.

*Woburn.*

Low-studded room, with poor light and ventilation. Small, dark dressing room in the corner contains old clothes and rubbish; the door stands open. Rubbish on top of old unused oven, — bottles, brushes, dippers, clothes, cobwebs and dirt. Utensils dirty. Shoes, trousers and rubbish on shelves. Ceiling black and peeling.

## LAUNDRIES.

The public laundry business is one which has developed to a remarkable extent within recent years, and it gives employment to thousands of persons, chiefly adult women. More than one-fourth of the establish-

ments visited employ more than 50 persons, and 3 of them employ more than 100. The heavy machine work is performed by men; but even for the lightest work girls are not extensively employed, although their services can be secured at lower rates than are commanded by women, because, so employers assert, they are far less attentive, and the amount and quality of their work is much inferior. In the 69 laundries visited there are employed 2,368 persons, divided as follows: men, 356; boys, 6; women, 1,860; girls, 146. Thirty-six of the 69 employ up to 20 persons each; 15 employ between 20 and 50 each; 15, between 50 and 100; and 3, between 100 and 160.

In the establishments of any considerable size the bundles are brought to the "markers," who open them, mark each piece if not already marked, and separate the "flat" from the "starched" work. The work of the markers is the most disagreeable of all, since each piece must be handled and examined separately. After sorting, the clothes are conveyed to the washing machines, where they are churned up with hot water and soap or washing powder for about twenty minutes. A bleaching agent is commonly added, to prevent the dingy or dirty look which otherwise they are likely to acquire. After removal from the washing machines they are transferred to rapidly revolving centrifugal machines, which quickly throw out the excess of water. A small proportion of special work is performed by hand in tubs.

After treatment in the centrifugal machines the articles are dried on racks in rooms heated to high temperatures by means of steam pipes. From the drying rooms the "flat work" goes directly to the mangles, by which it is ironed and folded ready for delivery. The "starched work" is treated with starch, usually by feeding into a starching machine, and the ironing is done in part by hand and in part by machinery. The finished material is conveyed to the sorting room, and after sorting is bundled for delivery.

The washing machines are run by men, and part of the heavy ironing is also done by men, but the rest of the work is done almost entirely by women.

In almost all of the establishments in which machinery is employed it is well protected; in 5 it is only partially protected. In 1, in which the machinery is not only not well guarded but also not easily stopped, a sign is posted which reads: "This machine is dangerous. Run it at your own risk!" but it is to be said that this place is small, employing only 4 persons, and that no accidents have occurred in thirteen years.

The mangles in use are in almost all cases equipped with a clutch, which, in the event of engagement of the operative's fingers, stops the machine instantly, and accidents are rare. In one establishment, em-

ploying 95 persons, 2 accidents had occurred in five years; in another, employing 15 persons, a hand was crushed some seven years ago, but no accident had occurred since; in another, employing 54 persons, 2 slight accidents, due to carelessness, had been recorded in fifteen years' operation.

The laundry business is not uncommonly regarded as one attended by more or less danger of contracting infective disease, because of handling the bed linen and body linen of sick persons; but the returns secured in this investigation do not support this assumption. Those who are most exposed to possible infection are the markers, who are obliged to examine and mark, if necessary, each piece submitted; but, while this work is disagreeable, there is no positive evidence that it is dangerous. As a rule, they are very skilful, and are not obliged to handle unduly the articles which they have to examine. Many of those questioned, including one who had worked continuously for twenty-two years, asserted that they had not lost a day in years of service. In one of the largest establishments, employing 150 persons, and in a large proportion of the others, it was said that very few cases of actual illness of any kind occurred in any year. In one, employing 52 persons, one or two cases of tuberculosis had occurred in twenty-seven years; but in a number of other large establishments no cases whatever were known to have occurred. It must be said, however, that in many of these establishments those who appear to be unable to do good work by reason of lack of strength are dismissed.

Many laundries refuse to handle very filthy clothes, and return such at once, and one goes so far as to cause their immediate destruction in the furnace; but some accept anything, no matter how foul, and report that the markers and sorters suffer no injury.

As a general thing, the establishments examined showed commendable conditions as to light, ventilation and general sanitation. In 3 of the entire number the light, and in 5 the ventilation, were distinctly bad. In 11 the water-closets were described as filthy. Several of the smaller places presented most unfavorable conditions. In one the pipe from the tank of the water-closet burst some years ago and has never been repaired, and the closet, which on the day of visit was full of excrement, has to be flushed with a bucket. In another, a "family laundry," the whole place was found to be dirty, the floor looking as though it had not been washed in months. Another, operated by 4 persons, in a dark front room and cellar, was in such a generally foul condition as to cause nausea.

On the whole, the establishments examined were open to but little criticism, and the employees appeared to be exceptionally well and strong.

# REPORT UPON INVESTIGATION

OF

# LOCAL OUTBREAKS OF INFECTIVE DISEASES.

# Report upon Investigation of Local Outbreaks of Infective Diseases.

Following is an account of the local outbreaks of infective diseases in which the assistance of the Board was requested: —

## Adams.[1]

During the latter part of the summer of 1905 typhoid fever became prevalent in Adams, and in the autumn assumed the proportions of a mild epidemic.

Prior to June, 1905, no cases of this disease had been reported to the local board of health since 1902, when a small epidemic occurred. One case was reported in June and 2 in the earlier part of September, 1905. Between August 23 and December 7, 74 cases were reported; and upon investigation, 20 unreported cases were discovered. The occurrence of these cases was as follows: —

| | Cases. | | Cases. |
|---|---|---|---|
| August, | 7 | October, | 51 |
| September, | 22 | December, | 2 |

Four additional cases were reported to the State Board of Health on December 13, subsequent to the visits of its representative, which were the last to be so reported, and at that date the epidemic presumably became extinct. The total number of cases reported and otherwise ascertained was 102.

At the request of the local board of health, the agent of the State Board of Health visited the town and investigated as to the source and the mode of spread of infection.

The cases were widely distributed over the town, and occurred among all classes of people. Of the 98 cases investigated, 46 were males and 52 were females; 32 per cent. were under seventeen years of age, 51 per cent. were from seventeen to thirty years of age, and 7 per cent. were over thirty. Rather more than 50 per cent. of the adults were mill operatives.

A large proportion of the persons affected either habitually used or had access to the public water supply. In some instances, however, the

[1] Reported in "Monthly Bulletin," February, 1906.

patient had used well water only. This was true of certain cases in outlying districts, unsupplied with town water. The mill operatives had access, in addition to public supply, to the private water supply in certain of the mills. In the case of one, at least, of these mills, this supply was the only one available upon certain days in August, when, owing to the shutting off of one of the principal mains, necessitated by alterations, the pressure in the distributing mains and service pipes of the public supply was very greatly lowered.

Investigation of the public water supply failed to disclose any facts proving this to be a means for the spread of infection. No cases of typhoid fever were found upon the water-sheds of either of the sources of public supply, and the same is true of the private supply above referred to. This latter is not intended for drinking purposes, and is unprotected from pollution. No cases of typhoid fever were, however, known to exist upon the shores of the stream yielding this supply.

Thirty-five per cent. of the cases occurred among the customers of one milk dealer, a number equivalent to about one-tenth of these customers. Upon investigation, it was found that a fatal case of typhoid fever had occurred in the family of one of the producers furnishing milk to the dealer; the patient was a child, who died September 29. There was no proof that this child infected the supply of milk from this source, although opportunity probably existed. This supply was excluded from the market about October 1. Seventeen other milk dealers among their customers had from one to nine cases of typhoid fever. In ten instances the patient obtained milk from private sources.

Careful study of the facts gained by investigation fails to show conclusively that either the public water supply or any of the sources of milk supply was the means whereby the contagion was spread. While it is true that cases of the disease were widely distributed throughout the town, it is likewise true that neither in numbers nor in thoroughness of distribution does this coincide with an epidemic from water-borne contagion. The fact that not over 35 per cent. of all cases were supplied with milk from one source, appears to relieve this source from the responsibility of the entire epidemic. The further fact, however, that a larger proportion of the users of this supply were infected than was the case with the users of milk from other sources, suggests that this milk may have carried contagion, infection occurring from the case of the boy above referred to.

In this epidemic, upon the evidence of the facts at hand, it is clearly impossible to assert that infection of either water or milk supply was the cause.

### Chesterfield.

Following is a report of the investigation of 6 cases of scarlet fever, which occurred in as many different families in West Chesterfield during the period March 8 to March 17. No cases of scarlet fever other than these had been known to have occurred in Chesterfield for a very long time.

It was stated that an evangelist from Boston held a series of revival meetings in a hall in the village during the week just preceding the outbreak, and that nearly every member of the community attended the meetings. Inasmuch as the first 2 cases to be reported originated in the family in which he boarded, it was believed in the town that the infection had been introduced by him from without.

The cases were effectively quarantined by the local board of health, and no others were reported.

### Falmouth.[1]

During the period July–November, 1905, 23 cases of diphtheria were reported to the board of health of Falmouth. Investigation by an agent of the State Board of Health showed that these cases were distributed among 11 families, and that 14 of them were evidently primary, the others being due to contact infection at home. Owing to the prevalence of the disease among the pupils of the grammar school, this school was closed by order of the local board of health. The families in which the disease was present were quarantined, and release from this condition was conditional on the return of a negative report on bacteriological examination of the patient's throat. Following these precautions the outbreak subsided, and finally died out completely.

It is probable that the occurrence of diphtheria in this town continued through a period of many weeks largely because of the existence of cases of mild infection among children, not recognized in some instances at least by reason of failure to employ bacteriological examination as an aid in diagnosis.

### Fiskdale (Sturbridge.)[2]

In response to a request from the local board of health for advice in regard to an epidemic in Fiskdale, a village in the town of Sturbridge, an investigation was conducted in April which revealed the presence of numerous cases of typhoid fever.

Prior to this outbreak, which occurred during the first two weeks of April, Fiskdale had been comparatively free from this disease. One case

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[1] Reported in "Monthly Bulletin," January, 1906.
[2] Reported in "Monthly Bulletin," April, 1906.

was reported in October, 1905, 2 were reported in February, and 1 was reported early in March, 1906.

At the time of the investigation 11 cases had been reported to the local board of health, the persons stricken having all been taken sick between March 25 and April 7.

Information obtained from the local physicians indicated that about 40 persons were then sick, some of whom were regarded as suffering from typhoid fever, while in others it was suspected. The symptoms generally present were: (1) fever; (2) diarrhœa; (3) abdominal pain; (4) prostration. In no instance had the serum test been applied.

The investigation included visiting of families in which sickness was present, and obtaining from many of the patients specimens of blood for the serum test; determining the source of the milk and water used by the patients; and inquiring into the nature of the private water supply of the Fiskdale Company.

The 44 cases of sickness investigated were distributed among 26 families, in 12 of which 2 or more persons were ill. A large proportion of the patients were French Canadians, the older persons being employed in the Fiskdale Cotton Mills. One of the patients, a young man who returned to his home in Fiskdale about April 1, was ill at the time of his arrival, and unquestionably acquired the disease out of town. In but one instance was the time relation between the onset of the disease in different members of the same family such as to admit of regarding a later case as secondary to an earlier.

The age periods were represented among the patients as follows: —

| | Cases. |
|---|---|
| One to five years, | 7 |
| Six to ten years, | 8 |
| Eleven to eighteen years, | 19 |
| Over eighteen years, | 10 |

Of these 44 cases, 23 were children in school or under the school age, 17 were mill operatives, and 3 were employed at home.

The distribution of these cases in the village was general. The 4 persons stricken in the fall, winter and early spring lived on Main Street. Those taken sick during the outbreak in April lived in different parts of the town, in some instances at a considerable distance from the village proper. A large proportion of the sick persons lived in houses owned by the Fiskdale Company.

The serum test for typhoid fever was applied in 29 cases, representing 20 families. In 17 instances the test was positive, and in 1, clinically typhoid fever in the third week of the disease, it was reported as "incom-

plete." Of the 11 cases in which the test was negative, the persons affected had been ill for less than one week. Of the 12 families in which several persons were sick, in 11 the serum test was applied to 1 or more members; and in 10 families it was positive in the case of at least 1 person. The tests were made in the laboratory of the State Board of Health.

In view of the results of the serum test, it seems justifiable to regard all of the patients who presented the same general symptoms as suffering from typhoid fever, and to assert that there was no room for doubt as to the nature of the epidemic.

The source of the *milk* used by the sick persons was determined in 30 cases. Each of the two principal milk dealers of the town supplied 13 of the patients, a third dealer supplied 3; and 1 patient used milk from a private source. In 4 instances the patient was a member of a family in which no milk was used.

The source of the *water* used by the infected persons in their homes was found to be as follows: —

| | |
|---|---|
| Fiskdale Company's system, | 36 |
| Wells, | 7 |

The 36 persons who used reservoir water for drinking purposes at home include many who had no other supply. This water is led into all of the 121 tenements let by the company, representing some 60 or 70 houses. Some of these houses have wells, but very few of these were in use. In many cases the reservoir water is the only supply present in the house. All of the 23 children affected, who naturally had no access to the mills, lived in families in which reservoir water was regularly used for drinking purposes. In but one instance did an individual in whose house both reservoir and well water were available regularly use the latter for drinking.

The 7 persons who depended for domestic water supply upon wells were all adults. Six of these lived in houses not supplied by the Fiskdale Company's system, and in families which obtained their water supply solely from wells on the premises. One of these 7 persons was taken sick two weeks after the return to her family of her brother, who on April 1 came to Fiskdale from out of town, and was at that time suffering from typhoid fever. This case was probably secondary. A second case was that of a young man in whose house reservoir water was used, but, it is alleged, not for drinking. The remaining 5 persons were all employed in the weave room of the No. 1 Mill, a part of the mill which, during the month of March, was supplied with reservoir water for drinking purposes.

It thus appears that, of the persons known to be ill at the time of the investigation (excluding the out-of-town case and the secondary case dependent upon it), all but 1 regularly drank reservoir water, either at home or at their place of employment.

The water used in the private system of the Fiskdale Company, and through service pipes carried into all of the dwelling houses owned by this company, is drawn from the Quinebaug River. It is taken from the tail race of the lower of the two mills, which derives its water power from a mill pond between this mill and one above. This pond receives surface drainage from nearby-streets, and house sewage from several dwellings on Main Street. Two sewers empty into this pond, one about 30 feet and another about 100 feet above the sluice which conveys water to the lower mill. It is probable that the sewage so discharged includes that from one or more of the houses on Main Street, in which typhoid fever occurred during the late winter and early spring. The houses in question are provided with privies, and the sewage does not include that from water-closets.

The outlets of these sewers stand in such relation to the sluice as to favor the entrance of the sewage into the sluice, and to prevent its dispersion through the mill pond.

Analysis of the water furnished by the Fiskdale Company showed it to be of much better quality than would have been supposed, in view of the facts just stated. This may be accounted for by the relatively high stage of the river, and the abundant flow of water. It is not at all inconsistent with specific pollution of the water with typhoid bacilli.

Prior to the installation of this system of water supply, several years ago, the Fiskdale Company, as required by statute, sought the advice of the State Board of Health with reference to a source of water supply. At that time it was proposed to draw water from certain tubular wells. The company was advised that the supply from these wells might safely be increased by proper filtration of the river water. In this advice was contained the implication that the unfiltered river water was unfit for public supply.

The facts gathered in the course of this investigation may be summarized as follows: —

(1) An outbreak of sickness, explosive in character, and involving no fewer than 40 persons, occurred during the first two weeks of April.

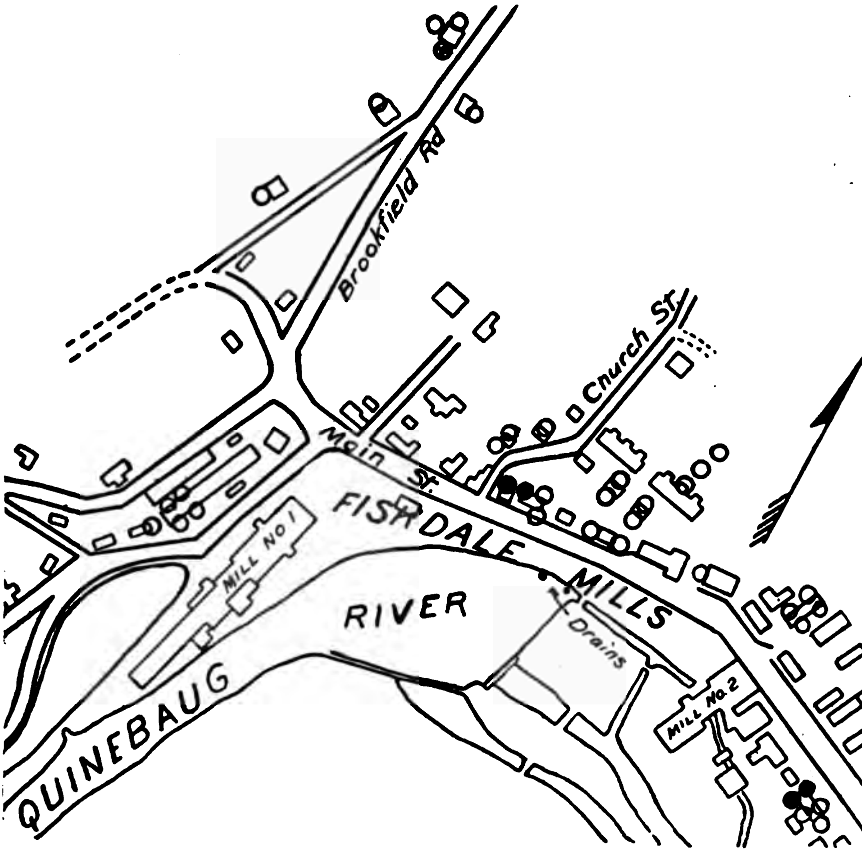
(2) Ample evidence shows the disease to have been typhoid fever.

(3) The persons affected included many children, individuals not employed in the mills.

(4) From the nature of the epidemic it is evident that it was not due to the spread of infection by contact.

(5) There is no evidence of the agency of milk as a vehicle of contagion.

(6) With but one or two exceptions, all of the affected persons had regularly used for drinking purposes, either at home or at their work, at least during the month of March, the water furnished by the Fiskdale Company.




MAP OF FISKDALE, SHOWING LOCATION OF CASES OF TYPHOID FEVER.

● Cases prior to the outbreak. ⊕ Cases from out of town.

○ Cases in present epidemic (two cases not shown).

(7) This water was drawn from a mill pond receiving sewage from near-by houses. It is probable that this sewage includes that from two dwellings in one of which typhoid fever occurred in October, and in another in the early part of March.

From these facts may be drawn the following conclusions: —

(1) The epidemic followed a sudden influx of infection at about the middle of March. This is shown by its explosive nature and by the date of the outbreak.

(2) The vehicle of contagion of necessity was one with a general distribution, and one which conveyed infection to many of the infected persons (children) in their homes.

(3) The only such vehicle common to practically all of the infected persons was water from the Fiskdale Company's supply. All of the facts point to water-borne infection. There is no evidence that milk, food stuffs or contact played any part in the outbreak.

(4) The water supplied by the Fiskdale Company is drawn from a source freely exposed to pollution; water which may easily have received typhoid bacilli from sewage infected by the persons who suffered from typhoid fever prior to the present outbreak.

The accompanying map shows the distribution of the cases, and also the outlets of the sewers in relation to the sluice whence the water supply is drawn.

## Hanson.

In February, in response to a request from the board of selectmen, an investigation was undertaken to determine the cause of a small outbreak of typhoid fever. The evidence which was gathered showed that between February 5 and 13, 9 cases of the disease occurred in five families living in the immediate vicinity of the railroad station in South Hanson. These five families constituted 70 per cent. of the customers of one milk dealer, and all of the persons stricken were users of the milk supplied by him.

The milkman sold the product of his own two cows and six or eight quarts which were brought daily from a farm in Halifax. Investigation of the premises of the Halifax producer showed nothing to point to the possibility of infection there. Moreover, no sickness existed in other families who used milk from the same farm, distributed by other persons. The premises of the milkman were dirty, and there was every evidence of extreme domestic untidiness. The cans and milk utensils were washed by the milkman's wife in the kitchen, with water from a well situated under the floor of an adjoining shed, and about 20 feet from an ordinary box privy adjoining the shed and opening out of it. A sample of the water was analyzed in the laboratory of the Board, and found to be extensively polluted with domestic sewage.

The second person to be seized was the milkman himself, but the original source of infection could not be determined. That it was upon the premises of the milk dealer seems most probable, and that it existed in the polluted well water is possible.

## LYNN.[1]

In response to a request from the board of health of Lynn for assistance in investigating the cause of an outbreak of typhoid fever, the State Board of Health sent a representative to that city, who spent several days in making a thorough investigation.

During July, August and the first few days of September nearly 50 cases of typhoid fever were reported to the local board of health. Eight of these cases occurred between July 10 and August 4, and they were so distributed both geographically and in point of time as to cause no special comment. Between August 4 and August 15 no cases were reported, but between August 15 and August 29, a period of two weeks, 37 persons were stricken with the disease; and between August 29 and September 4, 3 more cases were reported. The explosive character of the outbreak is thus clearly marked, and the time of its occurrence points to the early part of the month as the period within which the infection was spread.

A majority of the victims lived in the easterly part of the city, within a district bounded by Western Avenue, the Swampscott line, Essex Street and Franklin Street. Seven lived in the westerly part of the city, 5 in the southerly and 2 near the westerly end of Flax Pond. Of the 33 persons living in the district first named, all but 4 were taken sick within the last two weeks of August. Three were taken sick in July, all being of one family, and 2 of the cases were undoubtedly of secondary origin. Of the 15 persons who lived elsewhere than in this district, 3 were taken sick in July, 2 early in August and 2 during the first few days of September.

It appeared, then, that about 75 per cent. of all of the cases reported were taken sick during the latter half of August.

In 6 instances 2 or more of the same household were affected. In 3 of these the time relation between earlier and later cases was such as to render it probable that the later cases were secondary. The number of such secondary cases is 5. In 3 households in which more than one case occurred, the persons affected were all taken sick at about the same time.

The number of such multiple cases was 7. In but 4 instances was it at all probable that infection was acquired outside the city.

*Age Periods.* — The persons affected fell within the various age periods as follows: —

| | | | |
|---|---|---|---|
| Under five years, | 3 | Twenty-one to thirty years, | 12 |
| Six to ten years, | 6 | Thirty-one to forty years, | 9 |
| Eleven to fifteen years, | 9 | Forty-one to fifty years, | 2 |
| Sixteen to twenty years, | 6 | Over fifty years, | 1 |

[1] Reported in "Monthly Bulletin," August, 1906.

*Water Supply.* — All of the patients had access to or regularly used city water; but, inasmuch as the explosion was limited geographically, there was nothing to implicate the water supply.

*Milk Supply.* — The milk supply of the patients was furnished by several different dealers. Of the persons seized after August 14, 40 in number, 31, or 77 per cent., were supplied by one milkman, H. The remaining households were supplied by separate dealers. Of the 8 cases reported prior to August 15, the date of the beginning of the explosive outbreak, none received milk from the dealer above referred to. An investigation of all the dairies from which this particular milk supply was derived showed that upon none of them was any sickness present, and that it was wholly improbable that any infection could have originated there. Upon further inquiry, it was learned that among the persons reported sick in August was a young man who was admitted to the Lynn Hospital on August 28. At the time of admission he was doubtless well advanced in the disease, his temperature showing wide oscillation. According to his statement, he was employed by the milk dealer H. for a period of two or three weeks, his employment ending about August 10, and he began to feel sick during the following week. While with the milk dealer H. his duties included the washing of milk bottles.

The facts revealed in this investigation lead to the conclusion that the explosive outbreak which attracted the attention of the local authorities was due to milk supplied by the milkman H., and that the said milk received its infection upon H.'s premises, and not upon the premises of any of the producers. The cause of the infection in the other cases was not determined, but they were not more numerous than are likely to be found in a population of equal size at that period of the year, and, had it not been for the occurrence of the milk-borne cases, it is improbable that they would have attracted special attention.

## MEDWAY.[1]

Information received by the Board early in March led to the immediate investigation of sickness prevalent in a factory boarding-house in Medway. At the time of the inquiry no cases of typhoid fever had been reported to the local health officials either recently or for many months.

Investigation showed that within the period February 17–28, 13 of the 50-odd patrons of a boarding-house conducted for the use of the employees of the Hirsch & Park straw hat factory, and known as the Met-

[1] Reported in "Monthly Bulletin," March, 1906.

calf House, had been taken sick. The attending physician pronounced the illness grippe, her diagnosis being confirmed by consultation with a physician from Milford. Several of the patients were said to have recovered sufficiently to enable them to return to their homes, while 3 had been removed to hospitals in Milford. Two persons had gone to their homes in Maine, and of them nothing further is known, excepting that they were there under treatment for typhoid fever. Of the 11 others, 1, a young man, was under the care of a Medway physician, who regarded the case as one of typhoid fever, reporting it as such to the local health officials on March 4. The serum test in this instance was positive, as it was also in the case of 2 patients who were permitted to go to Swampscott with temperatures of 104°, and who there came under the care of a physician who at once caused this test to be applied.

A positive reaction was also yielded by the blood of all of the patients in the Metcalf House and in the hospitals at Milford.

One of the patients, a young woman of twenty-seven, who had been transferred to a private hospital in Milford on March 7, died after a few days' treatment for grippe. Autopsy showed the characteristic lesions of typhoid fever.

The nature of this outbreak having been established, effort was made to determine the vehicle of contagion and the source of infection.

The milk used in the Metcalf House was derived from the same source as that used in many households in the town, in none of which did cases of typhoid fever exist.

The water supply of the house was found to be from two sources: (1) a well, situated under the house; and (2) the Charles River.

The well in question had been in use up to about February 1, the water being employed for general domestic purposes, including drinking. On or about February 1 the use of this water was discontinued, by reason of its offensive odor and taste, and for it was substituted, according to the statement of the proprietor, water from a well near his own house, several hundred yards distant.

Analysis of the water from the well under the Metcalf House showed it to be extremely polluted, and comparable with crude sewage. The source of the pollution was not apparent. The well is 20 feet distant from a cesspool, but the latter is fully drained and is cemented.

The water from the Charles River is derived from a main in the neighboring street, which was laid several years ago for fire protection. This main is supplied by a pump drawing water from a raceway which leads from the river just below the Sanford Mills. This water was distributed from a tank in the top of the house to the bath room and the kitchen. In the latter it flowed from a faucet in the sink. According to the pro-

prietor and the housekeeper, this water was never used for drinking purposes or for cooking.

A review of the evidence gathered in the course of this investigation led to the following conclusions: —

1. The outbreak was probably due to a single influx of infection, for nearly all of the persons stricken were taken sick within a period of ten days. The date of this infection must have been on or about February 1.

2. The place of infection was in all probability the dining room of the Metcalf House, because: —

(*a*) All of the persons taken sick were boarders at this house, and their number includes several who did not lodge in the house.

(*b*) A considerable number of persons must have been exposed to infection at one and the same time, for the infection was single, and the proportion of cases to the boarders (over 30 per cent.) very large, implying the reception of infective material by a large number of individuals.

(*c*) The only place in which persons stricken could have been so exposed was in this dining room.

3. The vehicle of contagion was undoubtedly water, because: —

(*a*) Evidence is wanting which would point to milk or ice as vehicles, for persons other than the boarders at the Metcalf House using milk and ice from the same sources as those supplying this house were not affected.

(*b*) The sorts of food served at the boarding-house at this season of the year were not such as to render infection through this channel probable. Oysters and other shellfish had not been served, uncooked, at the house.

(*c*) Polluted well water was in use in the house up to within about two weeks of the outbreak, and possibly less. This water upon analysis showed the characteristics of crude sewage.

(*d*) Polluted water from another source, the Charles River, was at all times available in the house. At a time when drinking water was being brought from a distance, the filling of the water jar in the dining room from the tap in the kitchen sink yielding this water, by an uninstructed or careless servant, was quite possible. Such an accident would fully account for the outbreak.

4. The primary source of infection in this epidemic cannot be absolutely established. No case of typhoid fever is known to have existed upon the premises of the Metcalf House prior to this outbreak, nor is there evidence to show whether or not any one among the boarders conveyed to the house the infective material which led to the outbreak.

### Natick, Needham and Wellesley.[1]

During September and October 118 persons living in Natick, Wellesley and Needham were stricken with typhoid fever. Of this number, 105, or 89 per cent., were taken sick between September 9 and October 13, a period of five weeks. Fifty-six of these persons lived in Natick, 37 in Wellesley and 25 in Needham.

The general facts relative to the incidence and the distribution of these 118 cases of typhoid fever are set forth in the following table: —

*Table No. 1.*

| Week ending. | September. | | | | | October. | | | | November. | | Total No. Cases. | Population 1900. | Cases per 1,000 Population. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 8. | 15. | 22. | 29. | 6. | 13. | 20. | 27. | 3. | 10. | | | |
| Natick, | 1 | 3 | 2 | 2 | - | 3 | 5 | - | - | - | - | 16 | 9,488 | 6.2 |
| South Natick, | - | - | 7 | 14 | 11 | 3 | 1 | 1 | 3 | - | - | 40 | | |
| Wellesley, | - | - | 4 | 5 | 6 | 9 | 8 | 3 | - | 2 | - | 37 | 5,072 | 7.4 |
| Needham, | - | - | 2 | 7 | 4 | 3 | 9 | - | - | - | - | 25 | 4,016 | 6.2 |
| Total, | 1 | 3 | 15 | 28 | 21 | 18 | 23 | 4 | 3 | 2 | - | 118 | 18,576 | 6.37 |
| Per cent. of cases in each week, | 0.8 | 2.5 | 12.7 | 23.7 | 17.8 | 15.3 | 19.5 | 3.5 | 2.5 | 1.7 | - | - | - | - |
| | 4 cases, — 3.3 per cent. | | 105 cases, — 89.0 per cent. | | | | | 9 cases, — 7.7 per cent. | | | | | | |

### I. *The Epidemic in Natick.*

Fifty-six residents of Natick were stricken with typhoid fever between August 26 and October 27. Of this number, 16 lived in Natick proper and 40 in South Natick, a small village about one and a half miles from the center of the town.

The cases in Natick proper were distributed between August 26 and October 13. Of the 40 cases in South Natick, 32 (80 per cent.) occurred between September 10 and September 19. The epidemic was thus limited mainly to South Natick and was distinctly explosive in character. (See Fig. 1.) Nearly all of the families in which typhoid fever occurred lived in that part of South Natick which lies between Eliot Street, the Charles River and the Wellesley town line. Additional facts relative to the occurrence of the cases in South Natick are as follows: —

[1] Reported in "Monthly Bulletin," October, 1906.

| | No. Households. | No. Individuals. |
|---|---|---|
| Households in which two or more cases of typhoid fever occurred: — | | |
| 3 primary cases followed by 1 secondary, | 3 | 9 |
| 1 primary case followed by 1 secondary, | 2 | 4 |
| 2 primary cases, | 4 | 8 |
| 3 primary cases, | 1 | 3 |
| | 10 | 24 |
| Households in which but one case of typhoid fever occurred, | 16 | 16 |
| Total, | 26 | 40 |

It thus appears that the 40 cases of typhoid fever in South Natick were distributed among 26 families; that but 5 of the cases were secondary; and that, of these 5, only 2 occurred during the period September 10–29.

The 16 cases of typhoid fever in Natick proper occurred in 14 households, 3 of them being in the same family. All were primary. The distribution of the cases was widespread.

It does not appear that any of the victims of the epidemic in this locality acquired typhoid fever while living elsewhere.

*Water Supply.* — The water used by the stricken persons in practically every instance was derived from the public supply.

*Milk.* — Of the 40 victims who lived in South Natick, 32 (80 per cent.) bought milk from the same dealer, "B." This number includes 80 per cent. of the persons taken sick between September 10 and September 29. The outbreak of typhoid fever here was therefore chiefly among the customers of this milkman. The following table shows the number of individuals in South Natick who were taken sick during each week of the epidemic, grouped according to the source of their milk supply: —

*Table No. 2.*

| Week ending. | Milk Dealer. | | | | Private. | Unknown. | Total. |
|---|---|---|---|---|---|---|---|
| | A. | B. | D. | L. | | | |
| September 1, | - | - | - | - | - | - | - |
| September 8, | - | - | - | - | - | - | - |
| September 15, | - | 6 | - | - | 1 | - | 7 |
| September 22, | 2 | 11 | - | 1 | - | - | 14 |
| September 29, | - | 11 | - | - | - | - | 11 |
| October 6, | 1 | 1 | 1 | - | - | - | 3 |
| October 13, | - | 1 | - | - | - | - | 1 |
| October 20, | - | 1 | - | - | - | - | 1 |
| October 27, | - | 1 | - | - | 1 | 1 | 3 |
| Total, | 3 | 32 | 1 | 1 | 2 | 1 | 40 |

The 16 victims living in Natick proper obtained their milk from 8 different dealers. Four were supplied by "D," 3 by "F," 3 by "G" and

2 by "H." Four persons were supplied by 4 other dealers, "I," "J," "O" and "R." The 3 persons supplied by "G" were members of the same family, and were taken sick October 5, 7 and 13. It was alleged that these 3 persons on or about September 25 drank milk from another dealer, "A."

### *II. The Epidemic in Wellesley.*

In Wellesley 37 cases of typhoid fever occurred during September and October. Twenty-eight persons (80 per cent.) were taken sick between September 17 and October 13; 15 were stricken during the period September 9–29; 5 cases occurred after October 13.

Twenty-one of the victims, including 15 employees, were persons connected with Wellesley College. All of these individuals took one or more of their meals at the college.

Two persons, and possibly a third, acquired the disease while living elsewhere than in Wellesley. Four cases of typhoid fever occurred in households where the disease was already present, and were undoubtedly secondary.

*Water Supply.* — All of the persons stricken in Wellesley either regularly used or had access to water from the public supply.

*Milk Supply.* — The source of the milk used by the 37 victims was ascertained in all but 2 cases. Thirty-one used milk from dealer "A." Ten of the persons using this milk received it at their homes as individual customers; 21 had access to it at Wellesley College, which was supplied by dealer "A." Four victims obtained their milk from as many different milkmen, "D," "E," "N" and "Q," and, of these persons, 2 (supplied by "N" and "Q") were probably infected elsewhere than in Wellesley.

It thus appears that a large proportion of the Wellesley victims obtained their milk from the same source, dealer "A." Excluding the 2 cases in which infection took place out of town, and 2 in which the source of milk supply was not determined, 31 out of 33 (94 per cent.) of the persons stricken had access to the milk supplied by dealer "A." This dealer, besides supplying Wellesley College, distributed milk to about 30 individual customers in Wellesley.

### *III. The Epidemic in Needham.*

In Needham 25 persons were stricken with typhoid fever between September 15 and October 13. Thirteen of these were taken sick within the nine days September 15–24, and 12 within the eleven days October 2–13. Of the latter, 4 lived in Highlandville. With the exception of these, all of the victims were residents of the main village of Needham.

In no instance was it clear that the disease had been acquired out of town. One case was undoubtedly secondary.

*Water Supply.* — Practically all of the victims used or had access to the public supply.

*Milk Supply.* — Nineteen persons bought milk from dealer "C," one of the chief distributers in the village. Three, all residents of Highlandville, were supplied by dealer "E." The remaining 2 victims obtained their milk from two dealers, "K," who kept but one cow, and sold milk to a few customers only, and "P." One of the stricken persons used milk from a private supply, but asserted that occasional use had been made of milk from a store which was supplied by dealer "C."

### *IV. The Epidemic as a Whole.*

The fact that the outbreak of typhoid fever in the three communities was practically simultaneous suggests that what might appear to be three epidemics constituted essentially one.

By reference to Table No. 1 it will be seen that 89 per cent. of the cases occurred between the week of September 15 and that of October 13, and that during this period the disease reached its maximum degree of prevalence in each of the three towns.

The accompanying chart (Fig. 1) shows the explosive nature of the outbreak, and indicates the time relation between the epidemics in the several localities. The curves in this figure are based on the number of persons taken sick in each locality, by weeks.

From this it appears that the outbreak was most pronounced in South Natick, and that here it reached its climax about September 20, rapidly declining thereafter. In Wellesley the epidemic was somewhat more gradual in its development, not reaching its maximum until October, and persisting well into that month. In Needham there seem to have been two outbreaks, separated by an interval of about one week. It is worthy of note that, of the 9 cases constituting this second outbreak, 3 were in a part of the town remote from that in which the epidemic originated, and 1 was secondary. In Natick proper the prevalence of typhoid fever was at no time sufficiently marked to warrant its being regarded as epidemic.

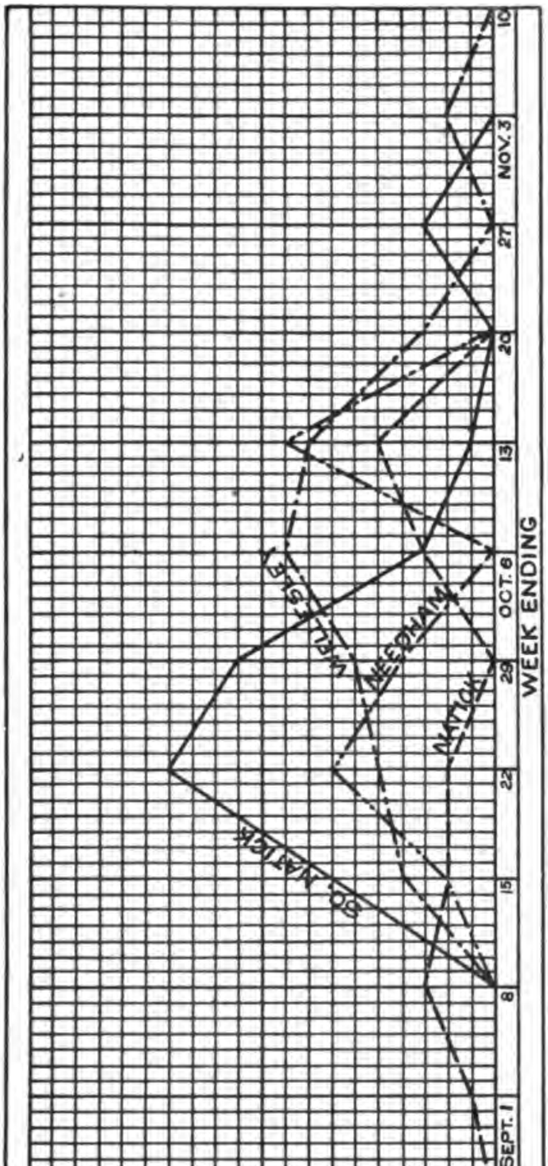



FIG. 1.— Weekly incidence of cases in South Natick, Natick, Wellesley and Needham.

*Age and Sex.* — The age and the sex of the stricken persons is shown by the following table: —

*Table No. 3.*

| LOCALITY. | Under 1 Year. | 1-5 Years. | 6-10 Years. | 11-15 Years. | 16-20 Years. | 21-30 Years. | 31-40 Years. | 41-50 Years. | 51-60 Years. | Over 60 Years. | Not ascertained. | Total. | Males. | Females. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natick, | - | 7 | 6 | 5 | 7 | 16 | 4 | 5 | 3 | - | 3 | 56 | 22 | 34 |
| Wellesley, | - | 2 | 3 | 1 | 3 | 13 | 4 | 2 | - | - | 9 | 37 | 12 | 25 |
| Needham, | - | 2 | 5 | 4 | 1 | 5 | 5 | - | - | - | 3 | 25 | 11 | 14 |
| Total, | - | 11 | 14 | 10 | 11 | 34 | 13 | 7 | 3 | - | 15 | 118 | 45 | 73 |

The proportion of cases to population was nearly the same in all three towns. In Natick and in Needham there were 6.2 cases per 1,000 population; in Wellesley, 7.4 cases.

*Milk Supply.* — The milk supply of the persons stricken in this epidemic was investigated, and the source ascertained in nearly every instance.

In the following table the several dealers from whom the victims obtained their milk are designated by letters, opposite which are indicated the number of persons in each locality who obtained milk from the source specified. This table further shows the proportion to the whole number of cases of the number among the users of milk from a given source.

*Table No. 4.*

| SOURCE OF MILK SUPPLY. | Natick, South Natick. | Wellesley. | Needham. | Total. | Per Cent. of Whole Number. |
|---|---|---|---|---|---|
| A, | 3 | 31 | - | 34 | 28.8 |
| B,[1] | 32 | - | - | 32 | 27.1 |
| C,[1] | - | - | 19 | 19 | 16.1 |
| D,[1] | 5 | - | - | 5 | 4.2 |
| E,[1] | - | 1 | 3 | 4 | 3.4 |
| F, | 3[2] | - | - | 3 | 2.5 |
| G, | 3 | - | - | 3 | 2.5 |
| H,[1] | 2 | - | - | 2 | 1.7 |
| I,[1] | 1 | - | - | 1 | 0.8 |
| J, | 1 | - | - | 1 | 0.8 |
| K, | - | - | 1 | 1 | 0.8 |
| L, | 1 | - | - | 1 | 0.8 |
| M, | - | 1 | - | 1 | 0.8 |
| N, | - | 1 | - | 1 | 0.8 |
| O, | 1 | - | - | 1 | 0.8 |
| P,[1] | - | - | 1 | 1 | 0.8 |
| Q, | - | 1 | - | 1 | 0.8 |
| R, | 1 | - | - | 1 | 0.8 |
| Private, | 2 | - | 1 | 3 | 2.5 |
| Undetermined, | 1 | 2 | - | 3 | 2.5 |
| Total, | 56 | 37 | 25 | 118 | 100.0 |

[1] Wholesale customers of "A," either regular or occasional.
[2] Members of same family; all drank milk from "A" about September 25.

Milk supply of victims according to source and locality.

From this it appears that dealers "A," "B" and "C" together furnished the milk used by 85 victims, or 72 per cent. of the whole number, while the remaining 33 obtained their milk from 17 different dealers.

It was ascertained that both "B" and "C" regularly purchased milk at wholesale from "A," and that 5 more of the milkmen concerned in the epidemic were occasional purchasers from this source. The 7 dealers who so purchased are indicated in the preceding table. The total number of victims who obtained milk from "A," or from any of the dealers who purchased at wholesale from him, was 98, which is 83 per cent. of the whole number.

The following table presents figures showing the number of cases of typhoid fever among the patrons of "A," or of the several dealers who obtained a part of their milk supply from him, grouped according to locality, together with percentages:—

*Table No. 5.*

| Place. | Total No. Cases. | Source A. | | Source B. | | Source C. | | Sources D. E. H. I. P. | | Total Per Cent from these Sources. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Per Cent. | No. | Per Cent. | No. | Per Cent. | No. | Per Cent. | |
| Natick, | 16 | - | - | - | - | - | - | 7 | 43.7 | 43.7 |
| South Natick, | 40 | 8 | 6.4 | 32 | 80.0 | - | - | 1 | 2.5 | 88.9 |
| Wellesley, | 37 | 31 | 83.7 | - | - | - | - | 1 | 2.7 | 86.4 |
| Needham, | 25 | - | - | - | - | 19 | 76.0 | 4 | 16.0 | 92.0 |
| Total number cases, | 118 | 34 | 28.8 | 32 | 27.1 | 19 | 16.9 | 13 | 11.0 | 83.0 |
| Number supplied by "A," etc. | 98 | | | | | | | | | |

Number of persons who obtained milk from "A" or from dealers who purchased from "A."

The accompanying chart (Fig. 2) shows in graphic form essentially the data contained in the preceding table. The double-hatched area indicates the number of victims who were supplied with milk by "A" or by the dealers who purchased from him.

The evident importance of the dairies of "A," "B" and "C" as possible factors in the epidemic caused them to be carefully inspected.

The dairy of "A" was found to be a large and well-conducted farm, situated in South Natick. The yield of milk from this dairy on September 1 was about 60 cans a day. Of this amount, 15 cans a day were sent to Wellesley College, about 6 cans a day were distributed to individual retail customers in Wellesley, some 3 cans a day were consumed on the farm, and the remainder was in large part sold by the can to various milk dealers who distribute in South Natick, Natick, Needham,

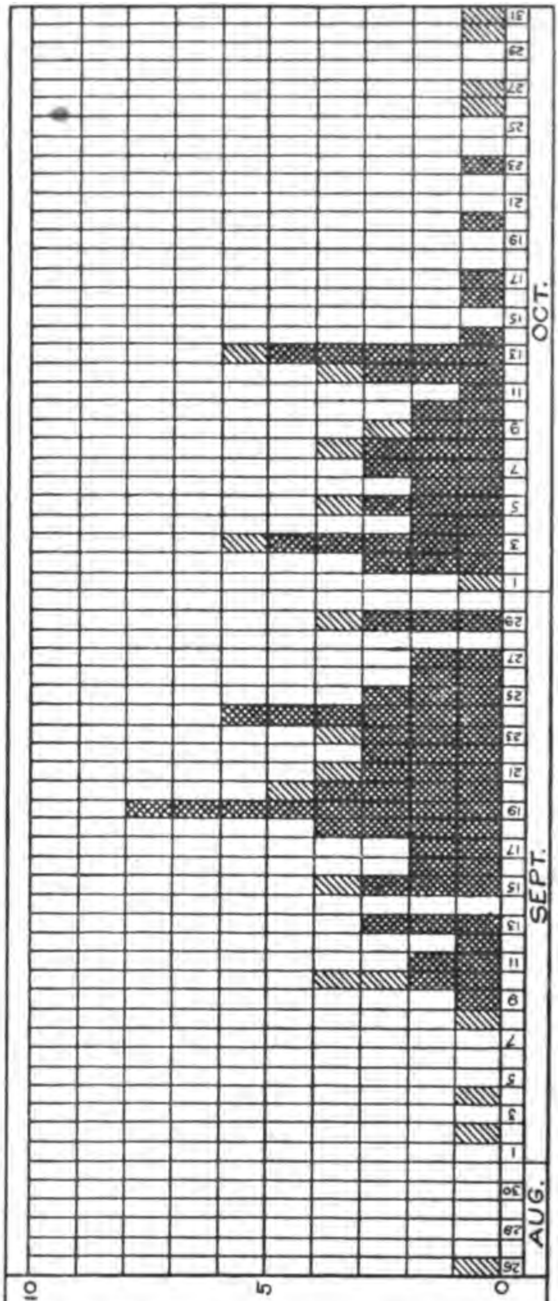



FIG. 2.

Newton and Brookline. No record was kept of these sales, the milk being paid for when taken. It was therefore impossible to determine the dates upon which these wholesale customers bought milk, or the number of cans purchased. It appears, however, that "B" and "C" were daily customers, and that "A" supplied to each from 2 to 3 cans of milk a day. The other wholesale purchasers bought from 2 to 10 cans at a time, and at irregular intervals.

The milk at the dairy of "A" is handled in a milk room adjoining one of the barns, and distant about forty feet from the dwelling house. This room is fairly well appointed, and at the time of inspection was clean. In this room the milk is strained, cooled by an aerator and again strained into a large mixing tank, whence it is drawn into the can. Wholesale purchasers furnish their own cans, which are filled from this tank. The milk is handled by five men, — four milkers and a foreman in charge of the milk room. The milk utensils are washed by the foreman in the milk room. The water on the premises is from the public supply.

It was ascertained that at the time of inspection, September 25, all of the persons employed upon this farm were healthy. As a matter of precaution, the agglutinative test was applied to the blood of each of the five men who handled the milk, with negative results. It appeared, however, that a young woman who had served as a waitress in the employees' dining room since July 5 had been taken sick September 16. She continued at her work until September 20, when she returned to her home in Boston. A day or two later she was admitted to the Boston City Hospital, with a diagnosis of typhoid fever. The agglutinative test was positive on the day of her admission to the hospital.

Inquiry alike from this young woman herself and from the employees on the farm showed that her duties did not include any of the procedures relative to the handling of the milk or of the milk utensils. The box privy used by this person was not disinfected until after September 25.

The sale of milk to other dealers was discontinued at this dairy after September 23, the product after that date being distributed to Wellesley College and to retail customers in Wellesley.

The dairy of "B," situated in South Natick, produced about 20 cans of milk a day. The proprietor supplemented this by from 2 to 3 cans a day purchased from the dairy of "A," the milk being distributed to about 125 customers in South Natick. The proprietor stated that the purchased milk was not mixed with that produced by the dairy. Investigation on September 25 showed no illness on the premises, and yielded no history of typhoid fever. The conditions here were found to be unsatisfactory for the proper handling of milk, but the proprietor at this time was making improvements.

One of the earliest victims in South Natick, who was taken sick September 10, lived near this dairy, but there was no evidence to show that she could have infected the milk in any way. The family of which this person was a member was supplied with milk from their own cow.

Three members of the family of "B" were subsequently stricken with typhoid fever, one on September 27, one on October 3 and a third on October 23. The milk from "B's" dairy was excluded from the Wellesley market by the local board of health about September 28.

The dairy of "C," a farm situated in Needham, produced about 18 cans of milk a day, an amount which was supplemented by from 2 to 3 cans a day purchased from the dairy of "A." It was alleged that this auxiliary supply was not mixed with the local product. The milk was distributed to about 300 customers, chiefly in Needham. The premises were found to be in a satisfactory condition. It could not be ascertained that any illness was then present, or that any one living there within recent months had been sick.

It was learned that a part of the product of this dairy, 8 cans of morning's milk, had for many weeks been sent daily to the Convalescent Home of the Children's Hospital, at Wellesley Hills, at which during September there were from 40 to 60 children. No cases of typhoid fever occurred among these children.

### V. *Summary. — Conclusions.*

A review of the evidence yielded by the investigation of this epidemic shows that a large number of persons living in three separate communities were stricken with typhoid fever within a relatively short period; in other words, that the outbreak was explosive, and at the same time widespread. It further shows that a very large proportion of the victims were users of milk sold by dealers who obtained a part of their supply from a common source, the dairy of "A," and that among the employees of this dairy a case of typhoid fever occurred about the middle of September.

The evidence at hand leads to the following conclusions relative to the cause of this epidemic: —

1. The victims must have acquired infection through a medium common to the three communities in which they lived. The only such medium demonstrable is the milk derived from the dairy of "A," as distributed either directly from this source or through the hands of other milk dealers.

2. The initial infection of this milk must have occurred on or about September 1. The earliest victims of the epidemic were stricken on September 10, and the minimum period of incubation in typhoid fever is about ten days. The period within which this milk was infective was

not prolonged; this fact is demonstrated by the explosive character of the outbreak.

3. The source of infection was probably the person employed as a waitress at the dairy of "A." Although no satisfactory proof exists of the manner in which infection of the milk may have occurred from this source, there is strong evidence that opportunity was not lacking. The fact that this individual showed no symptoms until September 16 does not prove that she may not have been a source of infection for a number of days prior to that date, while the additional fact that the origin of her own infection is not demonstrable subtracts nothing from the importance of her case as a factor in the epidemic.

This epidemic is instructive, as showing the possible results of the accidental infection of milk with typhoid bacilli, and of the importance attaching to the protection of market milk from such accidents.

### STOCKBRIDGE.[1]

During July and August, 21 cases of diphtheria, chiefly in children, were reported in Stockbridge, in that portion of the town known as the Furnace District, a community of 15 dwelling-houses, to 9 of which the cases were confined.

An investigation made by an agent of the State Board of Health, at the request of the local board, shows that the spread of the contagion was undoubtedly due to the premature release from quarantine of patients who were not yet free from diphtheria bacilli. In proof of this is the fact that in at least 5 instances another member of the same household was taken sick within a few days after a patient had been released from quarantine and allowed to mingle freely with his family.

The outbreak clearly demonstrates the importance of continuing quarantine upon patients with diphtheria, until it is certain that they are no longer capable of conveying infection to others. In this instance, the patients were released as soon as their throats appeared to the eye to be normal, and this was after an interval of from eight to twenty-one days subsequent to the onset of the disease.

There is no method of determining with certainty when a convalescent patient is free from the diphtheria bacilli other than bacteriological examination of the throat, and, in some instances, of the nose. To make release from quarantine conditional upon a negative report of such examination is by far the most effectual method which can be adopted by the health authorities of cities and towns for the prevention of the spread of this disease.

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[1] Reported in "Monthly Bulletin," August, 1906.

# General Health of the State in 1905.

# General Health of the State in 1905.

The number of deaths in the State in 1905 was 50,486, which was equivalent to a death-rate of 16.81 per 1,000 upon the census population of 3,003,680.

The mean death-rate of the four years 1902, 1903, 1904 and 1905 was 16.26, the same as for the four years 1901–04, which was much less than that of any four successive years since the beginning of registration in 1842.

The following figures are presented for the ten years ended with 1905: —

*Massachusetts.*

| Years. | Population.[1] | Deaths. | Death-rates. | Years. | Population.[1] | Deaths. | Death-rates. |
|---|---|---|---|---|---|---|---|
| 1896, . . . | 2,558,443 | 49,381 | 19.30 | 1901, . . . | 2,870,710 | 48,275 | 16.82 |
| 1897, . . . | 2,618,051 | 47,419 | 18.11 | 1902, . . . | 2,937,600 | 47,491 | 16.17 |
| 1898, . . . | 2,679,049 | 46,761 | 17.46 | 1903, . . . | 3,006,040 | 49,054 | 16.32 |
| 1899, . . . | 2,741,470 | 47,710 | 17.40 | 1904, . . . | 3,076,083 | 48,482 | 15.76 |
| 1900, . . . | 2,805,346 | 51,156 | 18.24 | 1905, . . . | 3,003,680 | 50,486 | 16.81 |

[1] Population estimated for intercensal years.

### Infective Diseases.

The death-rate from the principal infective diseases in 1905 was generally higher than that of the previous year. There was an increase in the number of deaths from cancer, cerebro-spinal meningitis, whooping cough, pneumonia, typhoid fever, measles and cholera infantum, and a decrease in the deaths from consumption, smallpox, diphtheria, scarlet fever and dysentery.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

*Deaths and Death-rates from Certain Diseases in Massachusetts, 1901-1905.*

| | 1901. | | 1902. | | 1903. | | 1904. | | 1905. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Deaths. | Death-rates per 10,000. | Deaths. | Death-rates per 10,000. | Deaths. | Death-rates per 10,000. | Deaths. | Death-rates per 10,000. | Deaths. | Death-rates per 10,000. |
| Smallpox, | 97 | .34 | 284 | .97 | 22 | .07 | 9 | .03 | 2 | .007 |
| Diphtheria, | 1,166 | 4.06 | 873 | 2.97 | 869 | 2.89 | 699 | 2.27 | 652 | 2.17 |
| Scarlet fever, | 385 | 1.34 | 313 | 1.07 | 510 | 1.70 | 138 | .45 | 117 | 0.39 |
| Typhoid fever, | 561 | 1.95 | 538 | 1.83 | 527 | 1.75 | 463 | 1.51 | 520 | 1.73 |
| Measles, | 173 | .60 | 333 | 1.13 | 247 | .82 | 160 | .52 | 177 | 0.59 |
| Cholera infantum, | 2,705 | 9.43 | 3,157 | 10.75 | 2,469 | 8.21 | 2,297 | 7.47 | 2,617 | 8.72 |
| Consumption, | 5,033 | 17.54 | 4,685 | 15.95 | 4,531 | 15.07 | 4,874 | 15.84 | 4,702 | 15.67 |
| Dysentery, | 223 | .78 | 193 | .66 | 188 | .63 | 184 | .60 | 182 | .60 |
| Whooping cough, | 210 | .73 | 337 | 1.15 | 519 | 1.73 | 117 | .38 | 218 | .73 |
| Pneumonia, | 4,772 | 16.62 | 4,583 | 15.60 | 5,190 | 17.27 | 5,100 | 16.58 | 5,378 | 17.93 |
| Cancer, | 2,080 | 7.25 | 2,141 | 7.29 | 2,243 | 7.46 | 2,421 | 7.87 | 2,501 | 8.33 |
| Cerebro-spinal meningitis, | 177 | .62 | 165 | .56 | 156 | .52 | 165 | .54 | 560 | 1.87 |

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1904 and 1905, by which it appears that the sum of the deaths from these twelve causes in 1905 was higher by 999 than those of 1904 from the same causes: —

*Deaths from Certain Infective Diseases in 1904 and 1905.*

| Diseases. | 1904. | 1905. | Increase. | Decrease. |
|---|---|---|---|---|
| Smallpox, | 9 | 2 | - | 7 |
| Diphtheria and croup, | 699 | 652 | - | 47 |
| Scarlet fever, | 138 | 117 | - | 21 |
| Typhoid fever, | 463 | 520 | 57 | - |
| Measles, | 160 | 177 | 17 | - |
| Cholera infantum, | 2,297 | 2,617 | 320 | - |
| Consumption, | 4,874 | 4,702 | - | 172 |
| Dysentery, | 184 | 182 | - | 2 |
| Whooping cough, | 117 | 218 | 101 | - |
| Pneumonia, | 5,100 | 5,378 | 278 | - |
| Cancer, | 2,421 | 2,501 | 80 | - |
| Cerebro-spinal meningitis, | 165 | 560 | 395 | - |
| Totals, | 16,627 | 17,626 | 1,248 | 249 |

## Infant Mortality.

The rate of infant mortality during the year 1905 was somewhat higher than that which prevailed during the four years 1901, 1902, 1903 and 1904, it being 141.4 for the year 1905, as compared with 133.6 for 1904, 139.5 for 1903, 140.4 for 1902 and 137.2 for 1901.

The total number of births which occurred during the year ended June 30, 1905, was 74,387, and the total deaths under one during the year ended Dec. 31, 1905, were 10,519.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1895, and June 30, 1896, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1905.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1896, 1897, etc. The births during these ten years were 727,324, and the deaths under one year were 106,367, which is equivalent to an infant mortality-rate of 146.2 per 1,000 births for the decade. The last half of the period shows a substantial gain over the first half, since the infantile death-rate in the last five years was 138.4 per 1,000 births, as compared with 154.2 in the first five years.

*Infant Mortality, Massachusetts: 1896-1905, Ten Years.*

| Years. | Births in Year ending June 30. | Deaths under One Year. | Death-rate under One Year per 1,000 Births. | Years. | Births in Year ending June 30. | Deaths under One Year. | Death-rate under One Year per 1,000 Births. |
|---|---|---|---|---|---|---|---|
| 1896, | 70,167 | 11,765 | 167.7 | 1901, | 72,559 | 9,952 | 137.2 |
| 1897, | 72,578 | 10,751 | 148.1 | 1902, | 71,770 | 10,075 | 140.4 |
| 1898, | 73,868 | 11,012 | 149.1 | 1903, | 73,618 | 10,269 | 139.5 |
| 1899, | 71,156 | 10,532 | 148.0 | 1904, | 74,791 | 9,992 | 133.6 |
| 1900, | 72,430 | 11,500 | 159.0 | 1905, | 74,387 | 10,519 | 141.4 |

Total births in ten years ended June 30, 1905, 727,324.
Total deaths under one in ten years ended Dec. 31, 1905, 106,367.
Mean infantile death-rate, 146.2 per 1,000 births.

## Smallpox.

During the years 1901–03, smallpox became epidemic to an unusual degree, but, owing to the vigorous and painstaking measures employed, in the years 1904 and 1905 it assumed practically the conditions which

prevailed in the two years immediately preceding those of the epidemic. The fatality from this disease was 4.5 per cent. in 1905, 9 per cent. in 1904 and 3.3 per cent. in 1903. The fatality in 1902, when the epidemic was at its height, was 11.9 per cent.

The total number of cases reported to this Board during the year 1905 was 44, and the deaths from this cause were 2. Of this number, 28 cases were those of males, with 2 deaths, and 16 were of females, with no deaths.

In the five years 1901–05, 3,644 cases had been reported to the State Board of Health, with 405 deaths, making a fatality of 11.1 per cent. In 1899 there were 105 cases reported, with 14 deaths, and in 1900, 104 cases, with 3 deaths; the fatality for these years being, respectively, 13.3 per cent. and 2.9 per cent.

In 1905 the largest number of cases occurred during the month of May, 14 being reported for that month. Only 1 case each was reported in July and October, and none during the months of March, November and December.

The following table shows the prevalence of the disease by months during the year 1905:—

| | Cases. | Deaths. | | Cases. | Deaths. |
|---|---|---|---|---|---|
| January, | 11 | 1 | July, | 1 | - |
| February, | 3 | - | August, | 3 | - |
| March, | - | - | September, | 2 | - |
| April, | 2 | 1 | October, | 1 | - |
| May, | 14 | - | November, | - | - |
| June, | 7 | - | December, | - | - |

Of the 44 cases reported to the Board, the largest number, 22, occurred in Lowell. The following table shows the distribution of this disease among the cities and towns of the State, together with the number of deaths in each:—

| | Reported Cases. | Deaths. | | Reported Cases. | Deaths. |
|---|---|---|---|---|---|
| Lowell, | 22 | - | Hyde Park, | 2 | - |
| Lawrence, | 6 | - | Haverhill, | 1 | - |
| Boston, | 5 | 1 | Lynn, | 1 | - |
| Everett, | 3 | 1 | New Bedford, | 1 | - |
| Quincy, | 3 | - | Totals, | 44 | 2 |

The following summary presents the number of reported cases and deaths in each year for the twenty-three years 1883–1905: —

*Summary of Several Years, 1883-1905.*

| Years. | Cases. | Deaths. | Years. | Cases. | Deaths. |
|---|---|---|---|---|---|
| 1883, | 21 | 5 | 1896, | 5 | - |
| 1884, | 9 | 3 | 1897, | 18 | 4 |
| 1885, | 32 | 19 | 1898, | 12 | - |
| 1886, | 2 | - | 1899, | 105 | 14 |
| 1887, | 18 | 3 | 1900, | 104 | 3 |
| 1888, | 32 | 9 | 1901, | 778 | 101 |
| 1889, | 15 | 6 | 1902, | 2,305 | 274 |
| 1890, | 6 | 1 | 1903, | 417 | 19[1] |
| 1891, | 5 | 3 | 1904, | 100 | 9 |
| 1892, | 19 | 2 | 1905, | 44 | 2 |
| 1893, | 45 | 9 | | | |
| 1894, | 185 | 83 | Totals, | 4,273 | 519 |
| 1895, | 1 | - | | | |

[1] Four of these deaths, which occurred in the first days of January, 1903, were those of cases reported in December, 1902, and in reckoning the fatality of cases should be classed with the deaths of 1902.

The total number of reported cases in the twenty-three years was 4,273 and the deaths of these were 519, or 12.1 per cent.

The following table presents the data obtained from the returns received since and including 1888. The returns made previous to that date did not contain information of a sufficiently definite character to be included in this summary.

*Smallpox in Massachusetts by Ages, and with Reference to Vaccination, 1888-1905.*

| Periods. | Vaccinated. | | Unvaccinated. | | Unknown. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Cases. | Deaths. | Cases. | Deaths. | Cases. | Deaths. | Cases. | Deaths. |
| 0-1 year, | 5 | - | 180 | 46 | 2 | - | 187 | 46 |
| 1-5 years, | 37 | - | 491 | 56 | 4 | 1 | 532 | 57 |
| 5-10 years, | 39 | - | 272 | 8 | 9 | - | 320 | 8 |
| 10-15 years, | 49 | - | 134 | 4 | 2 | - | 185 | 4 |
| 15-20 years, | 95 | 3 | 255 | 17 | 6 | 2 | 356 | 22 |
| 20-30 years, | 455 | 29 | 575 | 79 | 21 | 5 | 1,051 | 113 |
| 30-40 years, | 506 | 44 | 282 | 55 | 7 | 1 | 795 | 100 |
| 40-50 years, | 315 | 30 | 130 | 34 | 8 | - | 453 | 64 |
| Over 50 years, | 212 | 38 | 65 | 17 | 3 | 1 | 280 | 56 |
| Age unknown, | 14 | - | 12 | 5 | 10 | - | 36 | 5 |
| Totals, | 1,727 | 144 | 2,396 | 321 | 72 | 10 | 4,195 | 475 |

## Consumption.

The total number of deaths from this cause registered in 1905 was 4,702, a decrease of 172 deaths from the number of deaths occurring from this disease in 1904, and 171 more than occurred from the same disease in 1903. The death-rate from consumption was less in 1905 than that of any year of record, except that of 1903.

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903, 1904 and 1905: —

*Deaths and Death-rates from Consumption in Massachusetts, 1851-1905.*

| PERIODS. | Deaths. | Death-rates per 10,000. | PERIODS. | Deaths. | Death-rates per 10,000. |
|---|---|---|---|---|---|
| 1851-60, | 45,252 | 39.9 | 1901, | 5,033 | 17.5 |
| 1861-70, | 45,913 | 34.9 | 1902, | 4,685 | 15.9 |
| 1871-80, | 54,039 | 32.7 | 1903, | 4,531 | 15.1 |
| 1881-90, | 58,303 | 29.2 | 1904, | 4,874 | 15.8 |
| 1891-1900, | 54,374 | 21.4 | 1905, | 4,702 | 15.7 |

## TYPHOID FEVER.

The following table presents the deaths and death-rates of these cities from this cause during the year 1905: —

*Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1905.*

| CITIES. | Deaths from Typhoid Fever. | Death-rates per 10,000. | CITIES. | Deaths from Typhoid Fever. | Death-rates per 10,000. |
|---|---|---|---|---|---|
| Waltham, | 15 | 5.7 | Lowell, | 17 | 1.8 |
| Newburyport, | 8 | 5.5 | Medford, | 3 | 1.5 |
| Pittsfield, | 10 | 4.0 | Somerville, | 9 | 1.3 |
| Beverly, | 5 | 3.3 | Fitchburg, | 4 | 1.2 |
| Woburn, | 4 | 2.7 | Cambridge, | 12 | 1.2 |
| Salem, | 10 | 2.7 | Newton, | 4 | 1.1 |
| Springfield, | 19 | 2.6 | Quincy, | 3 | 1.1 |
| Northampton, | 5 | 2.5 | Malden, | 4 | 1.1 |
| Everett, | 7 | 2.4 | Chicopee, | 2 | 1.0 |
| Haverhill, | 9 | 2.4 | Taunton, | 3 | 1.0 |
| Lynn, | 17 | 2.2 | Fall River, | 11 | 1.0 |
| Worcester, | 27 | 2.1 | North Adams, | 2 | 0.9 |
| Lawrence, | 15 | 2.1 | Holyoke, | 4 | 0.8 |
| Boston, | 119 | 2.0 | Marlborough, | 1 | 0.7 |
| Brockton, | 9 | 1.9 | New Bedford, | 5 | 0.6 |
| Gloucester, | 5 | 1.9 | Melrose, | – | – |
| Chelsea, | 7 | 1.9 | Total, | 375 | – |

Death-rate for the above 33 cities, 1905, 1.9.

Following is a condensed summary from the report of 1900, from which it can be seen that a decided and continuous improvement in the death-rate from typhoid fever is taking place: —

*Death-rates from Typhoid Fever per 10,000, 1871-1905, Massachusetts.*

| | | | |
|---|---|---|---|
| 1871-75, | 8.2 | 1891-95, | 3.4 |
| 1876-80, | 4.2 | 1896-1900, | 2.6 |
| 1881-85, | 4.1 | 1901-05, | 1.9 |
| 1886-90, | 4.6 | | |

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904 and 1905 were, respectively, 1.95, 1.83, 1.75, 1.75 and 1.73 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Waltham (5.7), Newburyport (5.5) and Pittsfield (4.0); and the lowest occurred in Holyoke (0.8), Marlborough (0.7) and New Bedford (0.6). Melrose reported 4 cases of typhoid fever, with no deaths.

## Diphtheria.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1900, and for the single years 1901, 1902, 1903, 1904 and 1905: —

*Deaths and Death-rates from Diphtheria per 10,000, 1876-1905, Massachusetts.*

| Years. | Deaths. | Death-rates. | Years. | Deaths. | Death-rates. |
|---|---|---|---|---|---|
| 1876-80, | 13,676 | 15.8 | 1901, | 1,166 | 4.1 |
| 1881-85, | 8,944 | 9.5 | 1902, | 878 | 3.0 |
| 1886-90, | 8,857 | 8.4 | 1903, | 869 | 2.9 |
| 1891-95, | 7,652 | 6.4 | 1904, | 699 | 2.3 |
| 1896-1900, | 6,331 | 4.7 | 1905, | 652 | 2.2 |

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

## Other Preventable Diseases.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum and whooping cough for the period of forty years, 1866–1905.

*Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866-1905.*

| | Measles. | | Scarlet Fever. | | Dysentery. | | Cholera Infantum. | | Whooping Cough. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Deaths. | Death-rates. | Deaths. | Death-rates. | Deaths. | Death-rates. | Deaths. | Death-rates. | Deaths. | Death-rates. |
| 1866-70, . . | 1,081 | 1.6 | 4,670 | 6.8 | 3,244 | 4.7 | 6,943 | 10.1 | 1,481 | 2.1 |
| 1871-75, . . | 1,133 | 1.4 | 6,782 | 8.6 | 2,191 | 2.8 | 12,453 | 15.8 | 1,561 | 2.0 |
| 1876-80, . . | 742 | 0.9 | 3,517 | 4.1 | 2,366 | 2.7 | 9,054 | 10.5 | 1,493 | 1.7 |
| 1881-85, . . | 1,007 | 1.1 | 2,504 | 2.7 | 1,601 | 1.7 | 9,894 | 10.5 | 1,213 | 1.3 |
| 1886-90, . . | 1,089 | 1.0 | 1,810 | 1.7 | 1,276 | 1.2 | 10,904 | 10.3 | 1,421 | 1.3 |
| 1891-95, . . | 815 | 0.7 | 2,857 | 2.4 | 1,083 | 0.9 | 13,426 | 11.2 | 1,445 | 1.2 |
| 1896-1900, . . | 948 | 0.7 | 1,358 | 1.0 | 1,434 | 1.1 | 11,865 | 8.9 | 1,465 | 1.1 |
| 1901-1905, . . | 1,090 | 0.7 | 1,463 | 1.0 | 970 | 0.7 | 13,245 | 9.1 | 1,401 | 1.0 |

The deaths from cerebro-spinal meningitis were 560, a marked increase over the preceding year, and represented a death-rate of 1.86 per 10,000 living.

There were 2 deaths from hydrophobia during the year and 1 from glanders.

# STATISTICAL SUMMARIES

OF

# DISEASE AND MORTALITY.

# STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. Since 1902, this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infective diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infective Diseases, — Diphtheria, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the reports of local boards of health forwarded during 1905 to the State Board as cases arose. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities

and towns, as shown by the census of 1905, constituted about 86 per cent. of the total population of the State. These reports are made under the requirements of the following statute: —

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the state board of health. The form of such reports shall be prescribed and furnished by the state board of health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

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NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in Section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

## I.

### The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the fourteen months ended Nov. 30, 1906. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also in a publication of the Board, a weekly bulletin, since and including 1883.[1]

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of only a portion of the population, the reporting places being chiefly the cities and large towns.

The population of the cities and towns contributing to these returns in these fourteen months was 2,153,376, or 72 per cent. of the total population.

The following items are embraced in this summary: —

Total deaths reported for each week.
Deaths of children under five years.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diphtheria.
Deaths from scarlet fever.
Deaths from measles.
Deaths from diarrhœal diseases.
Deaths from whooping cough.
Deaths from puerperal fever.
Deaths from malarial fever.
Deaths from erysipelas.
Deaths from cerebro-spinal meningitis.
Deaths from smallpox.
Deaths from influenza.
Deaths from hydrophobia.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

[1] The bulletin was changed from a weekly to a monthly publication in January, 1906.

*Summary Oct. 1, 1905, to Nov. 24, 1906.*

| | Total Deaths. | Deaths under Five Years of Age. | Consumption. | Acute Lung Diseases. | Typhoid Fever. | Diphtheria. | Scarlet Fever. | Measles. | Diarrhoeal Diseases. | Whooping Cough. | Puerperal Fever. | Malarial Fever. | Erysipelas. | Cerebro-spinal Meningitis. | Smallpox. | Influenza. | Hydrophobia. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1905.** | | | | | | | | | | | | | | | | | |
| October 7, | 626 | 223 | 61 | 55 | 12 | 7 | - | - | 45 | 3 | - | - | - | 8 | - | - | - |
| 14, | 627 | 208 | 58 | 57 | 18 | 11 | 1 | 1 | 35 | 2 | - | - | 1 | 4 | - | - | - |
| 21, | 597 | 171 | 52 | 42 | 12 | 11 | 1 | 1 | 41 | 4 | - | - | 1 | 6 | - | - | - |
| 28, | 547 | 153 | 45 | 58 | 12 | 6 | - | 3 | 33 | 1 | - | - | 1 | 1 | - | - | - |
| November 4, | 601 | 165 | 60 | 72 | 11 | 6 | 2 | 4 | 27 | 1 | - | - | 1 | 1 | - | - | - |
| 11, | 605 | 169 | 57 | 79 | 8 | 16 | 1 | 5 | 19 | 1 | - | - | 2 | 6 | - | - | - |
| 18, | 549 | 126 | 44 | 73 | 9 | 11 | 2 | 1 | 14 | 3 | 1 | - | - | 2 | - | - | - |
| 25, | 664 | 158 | 62 | 95 | 9 | 15 | 1 | 2 | 13 | 3 | - | 1 | 2 | 3 | - | - | - |
| December 2, | 588 | 154 | 64 | 119 | 5 | 15 | 1 | 1 | 3 | 1 | - | - | - | 6 | - | - | - |
| 9, | 629 | 184 | 50 | 133 | 7 | 9 | 1 | 5 | 18 | 1 | - | - | - | 1 | - | - | - |
| 16, | 615 | 185 | 59 | 117 | 10 | 21 | 4 | 15 | 7 | 3 | - | - | - | 2 | - | - | - |
| 23, | 612 | 162 | 52 | 109 | 7 | 9 | 2 | 8 | 4 | 2 | - | - | - | 4 | - | 1 | - |
| 30, | 651 | 190 | 66 | 112 | 6 | 14 | 4 | 6 | 9 | 3 | - | - | 2 | 5 | - | - | - |
| **1906.** | | | | | | | | | | | | | | | | | |
| January 6, | 658 | 172 | 53 | 195 | 5 | 6 | 1 | 4 | 5 | 5 | - | - | 5 | 6 | - | 2 | - |
| 13, | 655 | 194 | 48 | 135 | 12 | 8 | 2 | 5 | 12 | 3 | - | - | 1 | 5 | - | 1 | - |
| 20, | 671 | 169 | 70 | 123 | 7 | 9 | 1 | 5 | 10 | 2 | - | - | - | 10 | - | - | - |
| 27, | 674 | 208 | 44 | 145 | 2 | 10 | - | 7 | 9 | - | - | - | - | 12 | - | - | - |
| February 3, | 666 | 187 | 66 | 181 | 6 | 16 | 2 | 6 | 10 | 5 | 1 | - | 1 | 11 | - | - | - |
| 10, | 709 | 218 | 74 | 141 | 3 | 16 | 1 | 5 | 11 | 6 | 1 | - | 3 | 4 | - | 1 | - |
| 17, | 731 | 216 | 69 | 184 | 3 | 21 | 1 | 5 | 9 | 4 | - | - | 3 | 6 | - | - | - |
| 24, | 745 | 190 | 80 | 140 | 3 | 8 | 1 | 5 | 7 | 4 | 3 | - | - | 9 | - | 1 | - |
| March 3, | 751 | 220 | 74 | 156 | 3 | 11 | 1 | 4 | 11 | 5 | - | - | 3 | 8 | - | - | - |
| 10, | 739 | 232 | 60 | 142 | 7 | 14 | 3 | 4 | 12 | 7 | 1 | - | 1 | 7 | - | 1 | - |
| 17, | 703 | 227 | 55 | 122 | 4 | 8 | - | 6 | 8 | 2 | 1 | - | 3 | 13 | - | - | - |
| 24, | 760 | 220 | 67 | 161 | 4 | 11 | - | 7 | 8 | 7 | - | - | 2 | 17 | - | 1 | - |
| 31, | 788 | 251 | 71 | 150 | 5 | 11 | 9 | 5 | 6 | 6 | 1 | - | 2 | 9 | - | 2 | - |
| April 7, | 744 | 209 | 77 | 188 | 3 | 7 | 1 | 3 | 11 | 4 | 1 | - | 3 | 14 | - | - | - |
| 14, | 694 | 211 | 75 | 127 | 4 | 13 | - | 4 | 12 | 4 | 2 | - | 2 | 15 | - | 1 | - |
| 21, | 771 | 209 | 71 | 132 | 5 | 7 | 3 | 4 | 15 | 11 | - | - | 2 | 12 | - | - | - |
| 28, | 715 | 205 | 78 | 113 | 1 | 11 | 4 | 7 | 10 | 7 | - | - | 2 | 9 | - | - | - |
| May 5, | 704 | 212 | 65 | 114 | 4 | 13 | 2 | 7 | 15 | 7 | 2 | - | 3 | 17 | - | - | - |
| 12, | 708 | 199 | 51 | 92 | 3 | 8 | 5 | 5 | 13 | 10 | - | - | 5 | 13 | - | - | - |
| 19, | 713 | 194 | 56 | 108 | 5 | 11 | 2 | 5 | 13 | 11 | - | - | 5 | 14 | - | - | - |
| 26, | 674 | 187 | 69 | 76 | 3 | 10 | 5 | 2 | 8 | 9 | - | - | - | 7 | - | - | - |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 2, | 669 | 185 | 67 | 85 | 2 | 6 | 4 | 2 | 8 | 10 | – | – | 1 | 4 | – | – | – |
| 9, | 638 | 190 | 86 | 62 | 4 | 9 | 6 | 1 | 17 | 7 | – | – | 4 | 11 | – | – | – |
| 16, | 627 | 177 | 56 | 79 | 6 | 10 | 2 | 1 | 14 | 8 | – | – | 1 | 7 | – | – | – |
| 23, | 552 | 150 | 65 | 40 | 4 | 6 | 4 | 2 | 20 | 10 | 1 | – | – | 7 | – | – | – |
| 30, | 572 | 149 | 53 | 42 | 5 | 6 | 2 | – | 37 | 5 | 3 | – | 1 | 4 | – | – | – |
| July 7, | 587 | 212 | 46 | 40 | 6 | 3 | – | 1 | 66 | 5 | 1 | – | 1 | 6 | – | – | – |
| 14, | 628 | 243 | 52 | 47 | 7 | 5 | 3 | 2 | 84 | 10 | 2 | – | 1 | 3 | – | – | 1 |
| 21, | 720 | 281 | 66 | 35 | 3 | 4 | – | 2 | 119 | 8 | 1 | – | 1 | 3 | – | – | – |
| 28, | 714 | 326 | 57 | 25 | 8 | 4 | 1 | 1 | 157 | 8 | – | – | 1 | 6 | – | – | – |
| August 4, | 805 | 392 | 58 | 43 | 3 | 12 | 2 | 2 | 158 | 19 | 2 | 1 | 1 | 5 | – | – | – |
| 11, | 811 | 364 | 54 | 21 | 2 | 11 | 2 | 1 | 165 | 13 | – | – | 1 | 6 | – | – | – |
| 18, | 726 | 328 | 48 | 35 | 6 | 6 | – | – | 183 | 8 | 1 | – | – | 1 | – | – | – |
| 25, | 745 | 335 | 48 | 22 | 8 | 8 | – | – | 179 | 8 | – | 1 | 1 | 6 | – | – | – |
| September 1, | 752 | 319 | 56 | 36 | 12 | 9 | – | 2 | 148 | 4 | – | 1 | 1 | 6 | – | – | – |
| 8, | 725 | 294 | 55 | 34 | 14 | 9 | – | – | 76 | 8 | 1 | – | – | 2 | – | – | – |
| 15, | 717 | 283 | 68 | 32 | 17 | 9 | – | 1 | 105 | 6 | – | – | – | 5 | – | – | – |
| 22, | 743 | 294 | 56 | 54 | 15 | 14 | – | – | 107 | 9 | – | – | – | 1 | – | – | – |
| 29, | 647 | 226 | 70 | 55 | 14 | 5 | – | – | 76 | 5 | – | – | 1 | 1 | – | – | – |
| October 6, | 696 | 239 | 73 | 57 | 13 | 11 | 1 | – | 49 | 10 | 1 | 1 | – | 5 | – | – | – |
| 13, | 652 | 200 | 57 | 47 | 13 | 15 | 3 | – | 42 | 6 | 1 | – | – | 4 | – | – | – |
| 20, | 648 | 211 | 45 | 56 | 9 | 13 | – | – | 35 | 8 | – | – | – | 5 | – | – | – |
| 27, | 636 | 182 | 54 | 73 | 11 | 6 | 1 | – | 25 | 1 | – | – | – | 7 | – | – | – |
| November 3, | 604 | 168 | 64 | 56 | 13 | 13 | 1 | – | 18 | 6 | 1 | – | 2 | 2 | – | – | 1 |
| 10, | 587 | 142 | 49 | 72 | 5 | 21 | 1 | 1 | 16 | 3 | – | – | 1 | 2 | – | – | – |
| 17, | 663 | 188 | 55 | 86 | 7 | 14 | 3 | – | 17 | 4 | – | – | – | 1 | – | – | – |
| 24, | 636 | 166 | 58 | 86 | 3 | 9 | – | 1 | 11 | 4 | – | – | 2 | 1 | – | – | – |
| Totals, | 40,384 | 12,852 | 3,614 | 5,136 | 438 | 618 | 100 | 177 | 2,410 | 340 | 29 | 5 | 82 | 378 | – | 11 | 2 |
| Weekly average, | 674 | 214 | 60 | 86 | 7.3 | 10.3 | 1.1 | 2.9 | 40.0 | 5.1 | .5 | 0.1 | 1.4 | 6.3 | – | 1.8 | .03 |
| Rate per 1,000 deaths, | – | 317.5 | 89.0 | 127.6 | 10.8 | 15.3 | 1.6 | 4.3 | 59.3 | 7.6 | .7 | 0.2 | 2.1 | 9.3 | – | 2.7 | .04 |
| Rate per 1,000 population, | 18.75 | 5.97 | 1.68 | 2.39 | 0.20 | 0.29 | 0.05 | 0.08 | 1.12 | 0.16 | .01 | 0.002 | 0.04 | 0.18 | – | 0.005 | .0009 |

Average reporting population, . . . . . 2,153,376

*Condensed Statistics, embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the Fourteen Months ended Nov. 30, 1906.*

| | Deaths. | Average Number of Deaths in Each Week. | Percentage of Total Mortality. | Death-rate per 1,000 of Reporting Population. |
|---|---|---|---|---|
| Total deaths, | 40,384 | 674 | 100.00 | 18.75 |
| Deaths under five years, | 12,852 | 214 | 31.75 | 5.97 |
| Deaths from consumption, | 3,614 | 60 | 8.9 | 1.68 |
| Deaths from acute lung diseases, | 5,186 | 86 | 12.76 | 2.39 |
| Deaths from typhoid fever, | 438 | 7.3 | 1.08 | 0.20 |
| Deaths from diphtheria, | 618 | 10.3 | 1.53 | 0.29 |
| Deaths from scarlet fever, | 100 | 1.1 | 0.16 | 0.05 |
| Deaths from measles, | 177 | 2.9 | 0.43 | 0.08 |
| Deaths from diarrhœal diseases, | 2,410 | 40.0 | 5.98 | 1.12 |
| Deaths from whooping cough, | 340 | 5.1 | 0.76 | 0.16 |
| Deaths from puerperal fever, | 29 | 0.5 | 0.07 | 0.01 |
| Deaths from malarial fever, | 5 | 0.1 | 0.02 | 0.002 |
| Deaths from erysipelas, | 82 | 1.4 | 0.21 | 0.04 |
| Deaths from cerebro-spinal meningitis, | 378 | 6.3 | 0.98 | 0.18 |
| Deaths from smallpox, | - | - | - | - |
| Deaths from influenza, | 11 | 1.8 | 0.27 | 0.005 |
| Deaths from hydrophobia, | 2 | 0.03 | 0.004 | 0.0009 |

The usual observations upon the weekly mortality statistics are omitted, and the foregoing short table, containing the essential statistics, supplies their place. The omission is made because information of the same character is presented in a different form in Section IV. of these summaries. The chief difference consists in the fact that the information given in this section (I.) is entirely voluntary and is detailed by weeks, while that of Section IV. is required by statute, the data not being forwarded to the Board until after the close of the year. The population which furnishes the statistics presented in Section IV. is considerably larger than that embraced in Section I., but both populations consist of the more densely settled parts of the State.

## II.

### Fatality of Certain Diseases.

Since the year 1891 the following statistics relative to the fatality of certain diseases have been gathered from the published reports of local boards of health. Until the passage of the law in 1893 this was the only source from which figures could be obtained on which to base the fatality of diseases as compared with cases. When the law (chapter 302, Acts of 1893) requiring local boards of health to report all cases of contagious diseases to the State Board of Health first went into effect very few returns were made, and it was not until after public notice had been given by the State Board to every board of health throughout the State that these returns came in with any regularity. The practice by the local boards of health of reporting cases of contagious diseases is now so well established, and the returns are so complete, it is no longer deemed necessary to continue the former method of basing the fatality of certain contagious diseases on the figures obtained through the annual reports of local boards, but, instead, to make use of the more complete returns as received from day to day at this office.

The diseases embraced in this summary in 1905 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1905 is as follows: —

| | |
|---|---|
| Reported cases of diphtheria for the State, | 5,783 |
| Registered deaths from diphtheria, | 652 |
| Fatality (per cent ), | 11.3 |
| Reported cases of scarlet fever for the State, | 4,112 |
| Registered deaths from scarlet fever, | 117 |
| Fatality (per cent.), | 2.8 |
| Reported cases of typhoid fever for the State, | 3,064 |
| Registered deaths from typhoid fever, | 520 |
| Fatality (per cent ), | 17.0 |
| Reported cases of measles for the State, | 7,876 |
| Registered deaths from measles, | 177 |
| Fatality (per cent ), | 2.2 |

The following table presents the summary of these statistics for the fifteen years 1891–1905: —

### *Reported Cases of Infective Diseases in Massachusetts.*

*Diphtheria.*

[Pre-Antitoxin Period.]

| | 1891. | 1892. | 1893. | 1894. | Total. |
|---|---|---|---|---|---|
| Reported cases, | 2,444 | 3,033 | 2,919 | 4,936 | 13,332 |
| Deaths, | 575 | 891 | 926 | 1,376 | 3,768 |
| Fatality (per cent.), | 23.5 | 29.2 | 31.7 | 27.9 | 28.3 |

*Diphtheria.*

[Antitoxin Period.]

| | 1904. | 1905. | Total 1895–1905. |
|---|---|---|---|
| Reported cases, | 6,254 | 5,783 | 79,713 |
| Deaths, | 577 | 652 | 9,908 |
| Fatality (per cent.), | 9.2 | 11.3 | 12.4 |

*Scarlet Fever.*

| | 1904. | 1905. | Total 1891–1905. |
|---|---|---|---|
| Reported cases, | 3,441 | 4,112 | 76,042 |
| Deaths, | 109 | 117 | 4,167 |
| Fatality (per cent), | 3.2 | 2.8 | 5.5 |

*Typhoid Fever.*

| | | | |
|---|---|---|---|
| Reported cases, | 2,426 | 3,064 | 37,662 |
| Deaths, | 410 | 520 | 6,681 |
| Fatality (per cent.), | 16.9 | 17.0 | 17.7 |

*Measles.*

| | | | |
|---|---|---|---|
| Reported cases, | 11,662 | 7,876 | 117,505 |
| Deaths, | 163 | 177 | 1,613 |
| Fatality (per cent.), | 1.4 | 2.2 | 1.4 |

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1904 and 1905 are given and the total for the eleven years 1895 to 1905, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1905) it was 12.4 per cent., or less than half as large.

## III.

### Official Returns of Notified Diseases Dangerous to the Public Health, for the Year ended Nov. 30, 1906.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year ended Nov. 30, 1906, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: smallpox, scarlet fever, measles, typhoid fever, diphtheria, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy, trichinosis.

The whole number of cases of infective diseases reported to the Board in the year ended Nov. 30, 1906, under the provisions of this act was 33,596, which were divided as follows: —

| | |
|---|---|
| Reported cases of smallpox, | 35 |
| Reported cases of scarlet fever, | 5.162 |
| Reported cases of diphtheria, | 7,967 |
| Reported cases of typhoid fever, | 3,093 |
| Reported cases of measles, | 17,048 |
| Reported cases of cerebro-spinal meningitis, | 291 |
| Total, | 33,596 |

The summary for the thirteen years and three months 1893–1906 is as follows: —

| | Reported Cases of — | | | | | | Totals. |
|---|---|---|---|---|---|---|---|
| | Smallpox. | Scarlet Fever. | Diphtheria. | Typhoid Fever. | Measles. | Cerebro-spinal Meningitis. | |
| 1893 (four months only), | 35 | 2,914 | 1,109 | 1,525 | 1,503 | - | 7,086 |
| 1894, | 181 | 6,731 | 4,178 | 2,372 | 2,133 | - | 15,595 |
| 1895, | 1 | 6,194 | 7,806 | 2,438 | 4,868 | - | 21,307 |
| 1896, | 5 | 3,801 | 8,515 | 2,637 | 6,362 | - | 21,320 |
| 1897, | 18 | 5,495 | 7,613 | 2,104 | 12,695 | - | 27,925 |
| 1898, | 10 | 3,667 | 3,980 | 2,196 | 4,478 | - | 14,331 |
| 1899, | 105 | 5,349 | 7,134 | 2,776 | 12,355 | - | 27,719 |
| 1900, | 104 | 6,396 | 12,641 | 2,967 | 10,507 | - | 32,615 |
| 1901, | 778 | 4,356 | 9,793 | 2,689 | 9,398 | - | 27,009 |
| 1902, | 2,314 | 4,613 | 7,036 | 2,721 | 17,249 | - | 33,933 |
| 1903, | 422 | 5,877 | 6,888 | 2,955 | 9,430 | - | 25,572 |
| 1904, | 100 | 4,100 | 6,772 | 2,605 | 12,511 | - | 26,088 |
| 1905 (11 months), | 44 | 3,594 | 5,059 | 2,794 | 6,107 | 455 | 18,053 |
| 1906 (Dec. 1, 1905–Nov. 30, 1906), | 35 | 5,162 | 7,967 | 3,093 | 17,048 | 291 | 33,596 |
| Totals, | 4,147 | 68,249 | 96,491 | 35,872 | 126,644 | 746 | 332,149 |

By months these diseases were reported as follows: —

*Cases of Infective Diseases reported to the State Board of Health by Months from Dec. 1, 1905, to Nov. 30, 1906.*

| Months. | Smallpox. | Scarlet Fever. | Diphtheria. | Typhoid Fever. | Measles. | Cerebro-spinal Meningitis. |
|---|---|---|---|---|---|---|
| December, | - | 519 | 722 | 272 | 1,768 | 12 |
| January, | - | 592 | 669 | 116 | 2,642 | 39 |
| February, | - | 418 | 574 | 75 | 3,140 | 24 |
| March, | 5 | 534 | 595 | 121 | 3,799 | 58 |
| April, | - | 490 | 498 | 146 | 2,722 | 35 |
| May, | 6 | 570 | 497 | 113 | 1,704 | 51 |
| June, | 20 | 454 | 501 | 130 | 760 | 24 |
| July, | 3 | 249 | 368 | 136 | 299 | 13 |
| August, | - | 182 | 452 | 350 | 94 | 19 |
| September, | 1 | 240 | 720 | 747 | 24 | 8 |
| October, | - | 455 | 1,175 | 579 | 33 | 5 |
| November, | - | 459 | 1,201 | 308 | 63 | 8 |
| Totals, | 35 | 5,162 | 7,967 | 3,093 | 17,048 | 291 |

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the disease named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria throughout the year, Dec. 1, 1905, to Nov. 30, 1906, was 21.8; of scarlet fever, 14.1; of typhoid fever, 8.5; and of measles, 46.7. During the month of December the mean daily number of reported cases of these diseases was: for diphtheria, 23.3; scarlet fever, 16.7; typhoid fever, 8.8; and for measles, 57.0 (see columns marked A). Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for December were as follows: diphtheria, 10.7; scarlet fever, 11.8; typhoid fever, 10.4; and measles, 12.2 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year, Dec. 1, 1905, to Nov. 30, 1906, there were 10.7 in December, 9.9 in January, 9.4 in February, etc.

From this table it appears that the maximum prevalence of diphtheria was in November and the minimum in July. The prevalence in the last three months was greater than that of the first three months.

The prevalence of scarlet fever was above the mean in December, January, February, March, April, May, June, October and November, and below it in the remaining months, the maximum occurring in Jan-

uary and the minimum in August. In the previous year the maximum was in February and March and the minimum in August.

Typhoid fever was, as usual, below the mean in the intensity of its prevalence in the months January to July, inclusive, rising to a maximum in September.

The prevalence of measles was above the mean in December, January, February, March, April and May, and below it in the remaining months, the maximum occurring in March and the minimum in September and October.

*Certain Infective Diseases.— Seasonal Intensity of Prevalence.*

| Months. | Diphtheria. | | | Scarlet Fever. | | | Typhoid Fever. | | | Measles. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | | 1905. | 1906. | | 1905. | 1906. | | 1905. | 1906. | | 1905. |
| | A | B | B | A | B | B | A | B | B | A | B | B |
| | Mean Daily Number of Cases reported in Each Month. | Decimal Ratio. | Decimal Ratio. | Mean Daily Number of Cases reported in Each Month. | Decimal Ratio. | Decimal Ratio. | Mean Daily Number of Cases reported in Each Month. | Decimal Ratio. | Decimal Ratio. | Mean Daily Number of Cases reported in Each Month. | Decimal Ratio. | Decimal Ratio. |
| December,[1] . | 23.3 | 10.7 | 12.0 | 16.7 | 11.8 | 13.4 | 8.8 | 10.4 | 9.6 | 57.0 | 12.2 | 4.1 |
| January, . | 21.6 | 9.9 | 12.3 | 19.1 | 13.5 | 12.1 | 3.7 | 4.4 | 4.4 | 85.2 | 18.2 | 12.8 |
| February, . | 20.5 | 9.4 | 10.1 | 14.9 | 10.5 | 12.8 | 2.7 | 3.2 | 5.2 | 112.1 | 24.0 | 9.7 |
| March, . . | 19.2 | 8.8 | 8.3 | 17.2 | 12.2 | 12.8 | 3.9 | 4.6 | 2.0 | 122.5 | 26.2 | 11.7 |
| April, . . | 16.4 | 7.5 | 9.4 | 16.3 | 11.6 | 12.6 | 4.9 | 5.8 | 3.7 | 90.7 | 19.4 | 10.5 |
| May, . . | 16.0 | 7.3 | 10.7 | 18.4 | 13.0 | 12.4 | 3.6 | 4.2 | 3.6 | 55.0 | 11.8 | 12.5 |
| June, . . | 16.7 | 7.6 | 8.9 | 15.1 | 10.7 | 10.8 | 4.3 | 5.1 | 4.2 | 25.3 | 5.4 | 16.3 |
| July, . . | 11.9 | 5.5 | 7.0 | 8.0 | 5.7 | 5.6 | 4.4 | 5.2 | 5.6 | 9.6 | 2.1 | 9.7 |
| August, . . | 14.6 | 6.7 | 5.6 | 5.9 | 4.2 | 3.5 | 11.3 | 13.3 | 18.1 | 3.0 | 0.6 | 2.6 |
| September, . | 24.0 | 11.0 | 8.6 | 8.0 | 5.7 | 5.8 | 24.9 | 29.3 | 30.5 | 0.8 | 0.2 | 1.7 |
| October, . . | 37.9 | 17.4 | 13.6 | 14.7 | 10.4 | 8.8 | 18.7 | 22.0 | 19.4 | 1.0 | 0.2 | 4.7 |
| November, . | 40.0 | 18.3 | 16.2 | 15.3 | 10.8 | 12.6 | 10.3 | 12.1 | 12.9 | 2.1 | 0.4 | 17.3 |
| Mean, . | 21.8 | 10.0 | 10.0 | 14.1 | 10.0 | 10.0 | 8.5 | 10.0 | 10.0 | 46.7 | 10.0 | 10.0 |

[1] The figures for December, in the first two columns, are for 1905, and in the third column, for 1904.

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns, from Nov. 30, 1905, to Nov. 30, 1906.*

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Abington, | 8 | 110 | 7 | 2 | - | 1 | - | - |
| Acton, | 1 | 18 | 1 | - | - | - | - | - |
| Acushnet, | 1 | 4 | 1 | - | - | - | - | - |
| Adams, | 19 | - | 35 | 13 | - | - | - | - |
| Agawam, | 4 | - | 3 | 1 | - | - | - | - |
| Amesbury, | 20 | 1 | 13 | 34 | - | - | - | - |
| Amherst, | - | 1 | 5 | - | - | - | - | - |
| Andover, | 10 | 14 | 7 | 11 | - | - | - | - |
| Arlington, | 27 | 57 | 13 | 22 | 1 | - | - | - |
| Ashburnham, | - | 1 | - | - | - | - | - | - |
| Ashfield, | - | 3 | 6 | - | - | - | - | - |
| Ashland, | 8 | - | 2 | - | 8 | - | - | - |
| Athol, | 2 | 47 | 12 | - | - | 1 | - | - |
| Attleborough, | 10 | 24 | 2 | 4 | - | 1 | - | - |
| Auburn, | 5 | - | - | - | - | - | - | - |
| Avon, | 1 | 1 | 3 | - | - | - | - | - |
| Ayer, | 7 | 4 | 10 | 4 | 1 | - | - | - |
| Barnstable, | 1 | 15 | 2 | 4 | - | - | - | - |
| Barre, | 38 | 4 | 2 | 1 | - | - | - | - |
| Becket, | - | - | 1 | - | - | - | - | - |
| Bedford, | - | 24 | 5 | - | - | - | - | - |
| Belchertown, | 3 | - | - | - | 1 | - | - | - |
| Bellingham, | 4 | 1 | - | - | - | - | - | - |
| Belmont, | 5 | 2 | 1 | 5 | - | - | - | - |
| Berkley, | - | - | 2 | - | - | - | - | - |
| Berlin, | - | - | 3 | - | - | - | - | - |
| Bernardston, | - | - | 1 | - | - | - | - | - |
| Beverly, | 48 | 87 | 23 | 14 | - | 1 | - | - |
| Billerica, | 7 | 9 | 7 | - | - | 4 | - | - |
| Blackstone, | 1 | - | 12 | - | - | - | - | - |
| Blandford, | 1 | - | - | - | - | - | - | - |
| Bolton, | 4 | - | 2 | - | - | - | - | - |
| Boston, | 2,114 | 4,435 | 1,856 | 1,041 | 2,173 | 106 | 7 | - |
| Bourne, | 5 | - | - | - | - | - | - | - |
| Boxborough, | 1 | - | - | - | - | - | - | - |
| Boxford, | 1 | 1 | - | - | - | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Boylston, | 1 | 40 | - | - | - | - | - | - |
| Braintree, | 4 | 2 | 31 | - | - | - | - | - |
| Brewster, | - | 2 | - | - | . | - | - | - |
| Bridgewater, | 7 | 8 | 8 | 2 | - | - | - | - |
| Brimfield, | - | - | 1 | - | - | - | - | - |
| Brockton, | 76 | 89 | 87 | 67 | - | 1 | - | - |
| Brookfield, | 1 | - | - | 1 | - | - | - | - |
| Brookline, | 88 | 362 | 70 | 17 | 7 | - | - | - |
| Buckland, | - | 4 | 1 | - | - | - | - | - |
| Burlington, | - | - | 1 | - | - | - | - | - |
| Cambridge, | 563 | 656 | 181 | 121 | 151 | 26 | - | - |
| Canton, | 6 | 34 | 1 | - | - | - | - | - |
| Carlisle, | 1 | - | - | - | - | - | - | - |
| Carver, | - | - | 1 | - | - | - | - | - |
| Charlton, | 1 | - | 5 | - | - | - | - | - |
| Chelmsford, | 3 | 3 | 18 | 1 | - | - | - | - |
| Chelsea, | 51 | 286 | 32 | 34 | 9 | 2 | - | - |
| Cheshire, | 3 | - | - | - | - | - | - | - |
| Chester, | 2 | - | - | 1 | - | - | - | - |
| Chesterfield, | - | - | 6 | 5 | - | - | - | - |
| Chicopee, | 16 | 13 | 47 | 17 | 18 | 1 | - | - |
| Chilmark, | - | 3 | - | 2 | - | - | - | - |
| Clinton, | 9 | 12 | 8 | 1 | 1 | 2 | - | - |
| Cohasset, | - | - | 1 | - | - | - | - | - |
| Colrain, | - | - | 1 | - | - | - | - | - |
| Concord, | 13 | 20 | 15 | - | - | 1 | - | - |
| Cummington, | - | - | 1 | 1 | 1 | - | - | 2 |
| Dalton, | 2 | - | 8 | - | - | - | - | - |
| Dana, | - | 16 | - | 1 | - | - | - | - |
| Danvers, | 15 | 7 | 23 | 15 | - | 1 | - | - |
| Dartmouth, | 5 | 14 | 4 | 4 | - | - | - | - |
| Dedham, | 15 | 28 | 45 | 2 | 1 | 1 | - | - |
| Deerfield, | - | - | 1 | - | - | - | - | - |
| Dennis, | - | 5 | 1 | - | - | - | - | - |
| Dighton, | 2 | - | - | - | - | 1 | - | - |
| Douglas, | 1 | - | - | 8 | - | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Dover, | 1 | 2 | 1 | - | - | - | - | - |
| Dracut, | 18 | 5 | 3 | - | - | - | - | - |
| Dudley, | 1 | 1 | 1 | - | - | 1 | - | - |
| Dunstable, | 2 | 9 | - | - | - | | - | - |
| Duxbury, | 1 | 26 | 8 | 1 | - | | - | - |
| East Bridgewater, | 1 | 2 | 4 | - | - | - | - | - |
| East Longmeadow, | 1 | - | - | 1 | - | - | - | - |
| Eastham, | - | - | 1 | - | - | - | - | - |
| Easthampton, | 1 | - | - | 1 | - | - | - | - |
| Easton, | - | 2 | 7 | 5 | - | 1 | - | - |
| Edgartown, | 8 | - | - | - | - | - | - | - |
| Enfield, | - | - | - | - | 1 | - | - | - |
| Erving, | 1 | 3 | - | - | - | - | - | - |
| Essex, | 15 | 10 | 17 | 2 | - | - | - | - |
| Everett, | 97 | 275 | 55 | 61 | 5 | 1 | - | - |
| Fairhaven, | 10 | 49 | 14 | 1 | - | - | - | - |
| Fall River, | 73 | 6 | 82 | 46 | - | 11 | - | - |
| Falmouth, | 5 | 28 | - | 6 | - | - | - | - |
| Fitchburg, | 88 | 53 | 19 | 8 | - | - | - | - |
| Foxborough, | 2 | 57 | 1 | 3 | - | - | - | - |
| Framingham, | 8 | 8 | 5 | 5 | - | - | - | - |
| Franklin, | 4 | 252 | 8 | - | - | - | - | - |
| Freetown, | - | - | 11 | 1 | - | - | - | - |
| Gardner, | 44 | 200 | 88 | 10 | - | - | - | - |
| Gay Head, | - | 1 | - | - | - | - | - | - |
| Georgetown, | - | 1 | - | - | - | - | - | - |
| Gill, | - | - | 1 | - | - | - | - | - |
| Gloucester, | 198 | 6 | 33 | 4 | - | - | - | - |
| Goshen, | - | - | 1 | - | - | - | - | - |
| Grafton, | 8 | 4 | 26 | - | - | - | - | - |
| Great Barrington, | 10 | - | 10 | - | - | - | - | - |
| Greenfield, | 5 | 1 | 1 | 4 | - | - | - | - |
| Greenwich, | 2 | - | - | - | - | - | - | - |
| Groton, | 1 | 30 | - | - | - | - | - | - |
| Groveland, | 8 | - | 1 | 4 | - | - | - | - |
| Hadley, | 5 | 1 | 7 | 1 | - | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Halifax, | - | 2 | 1 | - | - | - | - | - |
| Hamilton, | - | - | 1 | - | - | - | - | - |
| Hampden, | - | - | 4 | - | - | - | - | - |
| Hanson, | 1 | - | 2 | 3 | - | 1 | - | - |
| Hardwick, | 38 | 2 | 5 | - | - | - | - | - |
| Harvard, | - | 3 | 5 | - | - | - | - | - |
| Hatfield, | 6 | 2 | 1 | - | - | - | - | - |
| Haverhill, | 151 | 57 | 152 | 85 | 89 | 7 | - | 9 |
| Hingham, | 4 | 2 | 11 | 1 | - | - | - | - |
| Holbrook, | 5 | - | 8 | 2 | - | - | - | - |
| Holden, | - | 27 | 8 | 4 | - | - | - | - |
| Holliston, | 4 | 48 | 19 | - | - | - | - | - |
| Holyoke, | 94 | 20 | 59 | 10 | - | 1 | - | - |
| Hopedale, | 7 | 88 | 7 | 2 | - | - | - | - |
| Hopkinton, | 2 | - | 3 | 2 | - | - | - | - |
| Hubbardston, | 1 | - | - | 1 | - | - | - | - |
| Hudson, | 17 | 22 | 12 | 4 | - | - | - | - |
| Hull, | 3 | 2 | - | - | - | - | - | - |
| Huntington, | 2 | - | - | - | - | - | - | - |
| Hyde Park, | 45 | 136 | 28 | 12 | - | 1 | - | 14 |
| Ipswich, | 8 | 44 | 4 | 10 | - | - | - | - |
| Kingston, | - | 2 | 1 | 3 | 1 | - | - | - |
| Lancaster, | 2 | - | 1 | 2 | - | - | - | - |
| Lanesborough, | 11 | 2 | 1 | - | 1 | - | - | 17 |
| Lawrence, | 132 | 486 | 62 | 100 | - | 19 | 1 | - |
| Lee, | 1 | 9 | 15 | 4 | - | - | - | - |
| Leicester, | 9 | - | 1 | 2 | - | - | - | - |
| Lenox, | 5 | - | 1 | - | - | - | - | - |
| Leominster, | 120 | 192 | 6 | 9 | - | - | - | - |
| Lexington, | 1 | 113 | 3 | - | 2 | 2 | - | - |
| Leyden, | - | - | - | 1 | - | - | - | - |
| Lincoln, | - | 6 | 4 | - | - | - | - | - |
| Littleton, | 1 | 1 | - | - | - | 1 | - | - |
| Longmeadow, | - | - | 1 | - | - | - | - | - |
| Lowell, | 339 | 604 | 76 | 37 | - | 46 | - | - |
| Ludlow, | 2 | - | 5 | - | - | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Lunenburg, | 8 | 1 | - | - | - | - | - | - |
| Lynn, | 128 | 119 | 150 | 127 | - | 2 | - | - |
| Lynnfield, | 2 | 2 | - | 1 | - | - | - | - |
| Malden, | 102 | 674 | 72 | 45 | - | - | - | - |
| Manchester, | 7 | 4 | 7 | 1 | - | - | - | - |
| Mansfield, | 12 | 85 | - | 1 | - | - | - | - |
| Marblehead, | 23 | 2 | 32 | 7 | - | - | - | - |
| Marion, | - | - | 4 | 3 | - | - | - | - |
| Marlborough, | 7 | 328 | 6 | 15 | - | - | - | - |
| Marshfield, | 2 | 2 | - | - | - | - | - | - |
| Mattapoisett, | 2 | 2 | 1 | 1 | - | - | - | - |
| Maynard, | 17 | 53 | 1 | 3 | - | - | - | - |
| Medfield, | - | 1 | - | - | - | - | - | 7 |
| Medford, | 81 | 485 | 37 | 18 | 7 | - | - | - |
| Medway, | 1 | 26 | 2 | 12 | - | - | - | - |
| Melrose, | 20 | 45 | 36 | 1 | - | - | - | - |
| Mendon, | 3 | 3 | 2 | - | - | - | - | - |
| Merrimac, | 8 | - | - | - | - | - | - | - |
| Methuen, | 24 | 125 | 31 | 9 | - | - | - | - |
| Middleborough, | 2 | 18 | 1 | 1 | - | 1 | - | - |
| Middleton, | 1 | 2 | 1 | - | - | 1 | - | - |
| Milford, | 21 | 86 | 5 | 9 | - | - | - | - |
| Millbury, | 1 | 36 | 5 | 3 | - | - | - | - |
| Millis, | 1 | - | - | - | - | - | - | - |
| Milton, | 16 | 62 | 15 | 9 | 2 | - | - | - |
| Monroe, | - | - | 4 | - | - | - | - | - |
| Monson, | 5 | 2 | 2 | 2 | - | - | - | - |
| Montague, | - | - | 1 | - | - | - | - | - |
| Nahant, | 4 | - | 3 | - | - | - | - | - |
| Nantucket, | 1 | - | - | - | - | - | - | - |
| Natick, | 23 | - | 8 | 63 | - | - | - | - |
| Needham, | 25 | - | 4 | 29 | 1 | - | - | - |
| New Bedford, | 187 | 260 | 138 | 33 | 12 | 3 | 12 | - |
| New Braintree, | 1 | - | - | - | - | - | - | - |
| New Marlborough, | 1 | - | - | - | - | - | - | - |
| New Salem, | - | 1 | - | - | - | - | - | 3 |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Newbury, | 1 | 17 | - | - | - | - | - | - |
| Newburyport, | 30 | 5 | 18 | 32 | - | 1 | - | - |
| Newton, | 110 | 639 | 108 | 38 | 6 | - | - | - |
| Norfolk, | 1 | 1 | 4 | 1 | - | - | - | - |
| North Adams, | 57 | 1 | 28 | 24 | 1 | 1 | - | - |
| North Andover, | 1 | - | 5 | - | - | - | - | - |
| North Attleborough, | 13 | 14 | 30 | 2 | - | - | 1 | - |
| North Brookfield, | 1 | - | - | 1 | - | 1 | - | - |
| North Reading, | - | 2 | - | - | - | - | - | - |
| Northampton, | 36 | 3 | 25 | 14 | - | - | - | - |
| Northborough, | - | 12 | - | - | - | - | - | - |
| Northbridge, | 11 | 8 | 18 | 10 | - | - | 10 | - |
| Northfield, | - | 36 | 1 | - | - | - | - | - |
| Norton, | - | 4 | - | - | - | - | - | - |
| Norwell, | 1 | 1 | 7 | 3 | - | - | - | - |
| Norwood, | 4 | 169 | 44 | 7 | 1 | - | - | - |
| Oakham, | - | 7 | 6 | - | - | - | - | - |
| Orange, | 2 | 22 | 1 | 6 | - | - | - | - |
| Otis, | - | - | 1 | - | - | - | - | - |
| Oxford, | 1 | - | - | 9 | 2 | - | - | - |
| Palmer, | 4 | 131 | 12 | 4 | - | - | - | - |
| Paxton, | - | 1 | - | - | - | - | - | - |
| Peabody, | 24 | 13 | 57 | 4 | - | 2 | - | - |
| Pelham, | 1 | - | 1 | - | - | - | - | - |
| Pembroke, | 4 | 1 | 1 | 1 | - | - | - | - |
| Pepperell, | 2 | - | 7 | - | - | - | - | - |
| Petersham, | - | 2 | - | - | 2 | - | - | - |
| Phillipston, | 1 | 5 | 1 | - | - | - | - | - |
| Pittsfield, | 44 | 3 | 31 | 22 | - | 1 | - | - |
| Plainville, | - | 8 | 3 | - | - | - | - | - |
| Plymouth, | 9 | 9 | 4 | 8 | - | - | - | - |
| Princeton, | 1 | 13 | 2 | 5 | - | - | - | - |
| Provincetown, | 3 | - | - | 5 | - | - | - | - |
| Quincy, | 75 | 387 | 59 | 4 | 6 | - | 2 | - |
| Randolph, | 4 | - | - | 3 | 1 | - | - | - |
| Raynham, | - | - | - | - | 1 | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Reading, . . . . | 31 | 6 | 2 | 3 | - | - | - | - |
| Rehoboth, . . . . | - | - | 8 | - | - | - | - | - |
| Revere, . . . . | 37 | - | 10 | 6 | 6 | 1 | - | - |
| Rochester, . . . . | - | - | - | 3 | - | - | - | - |
| Rockland, . . . . | 1 | 126 | 25 | 13 | - | - | - | - |
| Rockport, . . . . | 3 | 2 | 2 | - | - | - | - | - |
| Rowley, . . . . | 4 | - | 8 | 14 | - | - | - | - |
| Royalston, . . . . | - | 2 | - | - | - | - | - | - |
| Russell, . . . . | - | 1 | - | - | - | - | - | - |
| Rutland, . . . . | - | - | - | 6 | 520 | - | - | - |
| Salem, . . . . | 184 | 187 | 78 | 37 | 4 | 2 | - | - |
| Salisbury, . . . . | 5 | 1 | 1 | 7 | 1 | - | - | - |
| Sandisfield, . . . . | - | - | 1 | - | - | - | - | - |
| Saugus, . . . . | 20 | - | - | 1 | - | - | - | - |
| Scituate, . . . . | 2 | 9 | - | - | - | - | - | - |
| Seekonk, . . . . | - | - | - | 4 | - | - | - | - |
| Sharon, . . . . | - | 20 | - | - | 2 | - | - | - |
| Sheffield, . . . . | 5 | 9 | - | 3 | - | - | - | - |
| Shelburne, . . . . | 1 | 1 | - | - | - | - | - | - |
| Sherborn, . . . . | - | 5 | 1 | - | - | - | - | - |
| Shirley, . . . . | 12 | 11 | - | - | - | - | - | - |
| Shrewsbury, . . . . | - | 1 | - | - | - | - | - | - |
| Somerset, . . . . | - | - | 1 | - | - | - | - | - |
| Somerville, . . . . | 225 | 286 | 169 | 70 | 28 | 5 | 1 | - |
| South Hadley, . . . | 19 | - | 2 | 1 | - | - | - | - |
| Southampton, . . . | - | 5 | 1 | - | - | - | - | - |
| Southborough, . . . | - | 1 | 1 | 1 | - | - | - | - |
| Southbridge, . . . | 52 | 4 | 4 | 7 | - | - | - | - |
| Southwick, . . . . | - | - | 1 | - | - | - | - | - |
| Spencer, . . . . | - | - | - | 2 | - | - | - | - |
| Springfield, . . . . | 251 | 85 | 248 | 108 | - | - | - | - |
| Sterling, . . . . | - | 3 | - | - | - | - | - | - |
| Stockbridge, . . . . | 27 | - | 3 | 2 | - | - | - | - |
| Stoneham, . . . . | 2 | - | 3 | - | - | - | - | - |
| Stoughton, . . . . | 8 | 30 | 9 | 1 | - | - | - | - |
| Stow, . . . . | - | 1 | 1 | 1 | - | - | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Continued.

| | Diphtheria. | Measles. | Scarlet Fever. | Typhoid Fever. | Tuberculosis. | Cerebro-spinal Meningitis. | Small-pox. | Whooping Cough. |
|---|---|---|---|---|---|---|---|---|
| Sturbridge, | 6 | - | - | 29 | - | - | - | - |
| Sudbury, | - | 81 | 2 | - | - | - | - | - |
| Sunderland, | - | - | 3 | - | - | - | - | - |
| Sutton, | 31 | 11 | 2 | - | - | - | - | - |
| Swampscott, | 5 | 9 | 10 | 3 | - | - | - | - |
| Swansea, | 1 | - | 8 | - | - | - | - | - |
| Taunton, | 32 | - | 29 | 6 | - | 9 | - | - |
| Templeton, | 9 | 132 | - | - | - | - | - | - |
| Tewksbury, | 15 | 6 | - | 1 | 2 | - | - | - |
| Tisbury, | 2 | 139 | - | - | - | - | 1 | - |
| Topsfield, | - | 32 | 17 | - | - | 1 | - | - |
| Townsend, | - | 3 | 1 | - | - | - | - | - |
| Truro, | 1 | - | - | - | - | - | - | - |
| Upton, | 7 | 167 | - | 1 | - | - | - | - |
| Uxbridge, | 3 | 17 | 17 | - | - | - | - | - |
| Wakefield, | 17 | 320 | 43 | 2 | - | - | - | - |
| Wales, | 1 | - | - | - | - | - | - | - |
| Walpole, | 9 | 140 | 17 | 1 | - | - | - | - |
| Waltham, | 190 | 419 | 71 | 41 | 13 | 2 | - | - |
| Ware, | 26 | 3 | 2 | - | - | - | - | - |
| Wareham, | 5 | - | 1 | 1 | - | - | - | - |
| Warren, | 3 | 3 | 3 | 6 | - | - | - | - |
| Warwick, | 5 | - | - | 1 | - | - | - | - |
| Watertown, | 27 | 100 | 26 | 6 | - | 4 | - | - |
| Wayland, | 3 | 7 | 2 | 1 | - | - | - | - |
| Webster, | 15 | 30 | - | - | - | - | - | - |
| Wellesley, | 5 | 141 | 15 | 29 | 3 | - | - | - |
| Wellfleet, | 1 | - | - | - | 1 | - | - | - |
| West Boylston, | - | 21 | - | - | - | - | - | - |
| West Bridgewater, | - | 1 | - | - | - | - | - | - |
| West Brookfield, | - | - | 1 | - | - | - | - | - |
| West Newbury, | 2 | - | - | - | - | - | - | - |
| West Springfield, | 12 | 1 | 6 | 2 | - | - | - | - |
| West Tisbury, | - | 2 | - | - | - | - | - | - |
| Westborough, | - | 8 | 3 | 1 | - | - | - | - |
| Westfield, | 28 | 97 | 7 | 35 | 8 | 1 | - | - |

*Cases of Infective Diseases reported to the State Board of Health from 309 Cities and Towns from Nov. 30, 1905, to Nov. 30, 1906* — Concluded.

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|---|---|---|---|---|---|---|---|---|
| Westford, | - | - | 2 | - | - | - | - | - |
| Westhampton, | - | - | 1 | 1 | - | - | - | - |
| Westminster, | - | 30 | 10 | 1 | - | - | - | - |
| Weston, | - | 61 | - | 1 | - | - | - | - |
| Westport, | - | 4 | 1 | - | - | 1 | - | - |
| Westwood, | 4 | 3 | 6 | - | - | - | - | - |
| Weymouth, | 10 | 11 | 21 | 4 | - | - | - | - |
| Whately, | - | - | 1 | - | - | - | - | - |
| Whitman, | 7 | 28 | 3 | 5 | - | - | - | - |
| Wilbraham, | - | 2 | 3 | 2 | - | - | - | - |
| Williamsburg, | - | - | 5 | 2 | - | - | - | - |
| Williamstown, | 4 | 3 | 3 | 4 | - | - | - | - |
| Wilmington, | 2 | 68 | 7 | 1 | - | - | - | - |
| Winchendon, | 4 | 158 | 3 | 4 | - | - | - | - |
| Winchester, | 30 | 91 | 5 | 2 | 2 | - | - | - |
| Windsor, | - | - | 8 | - | - | - | - | - |
| Winthrop, | 12 | 124 | 13 | 6 | 2 | - | - | - |
| Woburn, | 11 | 78 | 6 | 15 | - | 9 | - | - |
| Worcester, | 689 | 445 | 122 | 74 | - | 1 | - | - |
| Wrentham, | - | 21 | 4 | - | - | - | - | - |
| Yarmouth, | - | - | 4 | - | - | - | - | - |
| Totals, | 7,967 | 17,048 | 5,162 | 3,093 | 3,101 | 291 | 35 | 52 |

Leprosy occurred in the following place: —

| | |
|---|---|
| Lynn, | 1 |

Hydrophobia occurred in the following places: —

| | |
|---|---|
| Attleborough, | 1 |
| Salem, | 1 |
| Total, | 2 |

Erysipelas occurred in the following places: —

| | |
|---|---|
| Fall River, | 1 |
| Lynn, | 1 |
| North Adams, | 1 |
| Revere, | 1 |
| Salem, | 4 |
| Springfield, | 3 |
| Total, | 11 |

Chicken-pox occurred in the following places: —

| | |
|---|---|
| Barnstable, | 1 |
| Canton, | 1 |
| Chelsea, | 7 |
| Everett, | 8 |
| Fairhaven, | 2 |
| Hyde Park, | 9 |
| Pittsfield, | 3 |
| Total, | 31 |

*List of Cities and Towns from which no Reports were received.*

*I. Cities.*

None.

*II. Towns having a Population of More than 5,000.*

None.

*III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.*

| | | |
|---|---|---|
| Charlemont, | Cottage City, | Orleans, |
| Chatham, | Hanover, | Sandwich, |
| Clarksburg, | Harwich, | West Stockbridge. — 11. |
| Conway, | Hinsdale, | |

*IV. Towns having Less than 1,000 Inhabitants.*

| | | |
|---|---|---|
| Alford, | Leverett, | Rowe, |
| Ashby, | Mashpee, | Savoy, |
| Egremont, | Middlefield, | Shutesbury, |
| Florida, | Monterey, | Tolland, |
| Gosnold, | Montgomery, | Tyngsborough, |
| Granby, | Mount Washington, | Tyringham, |
| Granville, | New Ashford, | Washington, |
| Hancock, | Peru, | Wendell, |
| Hawley, | Plainfield, | Wenham, |
| Heath, | Plympton, | Worthington. — 34. |
| Holland, | Prescott, | |
| Lakeville, | Richmond, | |

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 141, State House, Boston.

## IV.

### Official Returns of Deaths in Cities and Large Towns (Revised Laws, Chapter 75, Section 12).

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1905 are somewhat in excess of the list of 1904, the taking of the State census of 1905 having added 6 towns to the list of places having a population of more than 5,000 in each during the five years which have elapsed since the taking of the State census in 1900, viz., Abington, Grafton, Ipswich, Maynard, South Hadley and Swampscott. The net gain by the addition of new towns to the list is 31,344.

Two towns, Hingham and Williamstown, which had more than 5,000 inhabitants in 1900, have fallen below 5,000 in their populations in 1905, Hingham dropping from 5,059 to 4,819 and Williamstown [1] from 5,013 to 4,425. These two towns have made returns this year.

Although the census population of Easton for 1905 is but 4,909, a return was sent in by that town, this being the second time it has appeared in the list. Reading has also voluntarily contributed returns of deaths to the Board during the past eight years, although not required by law to do so.

The list for the year 1905 includes 101 cities and towns. The total population of this group of cities and towns, as shown by the census of 1905, was 2,588,962, or about 86 per cent. of the total population of the State.

The whole number of registered deaths in these towns in 1905 was 43,410, and the death-rate, as calculated from the foregoing census population, was 16.77 per 1,000 of the living population, that of the previous year having been 15.47 per 1,000, and that of 1903, 16.14 per 1,000.

The death-rate for the year 1905 was somewhat higher than that of the three preceding years, due, in part, to the fact that for those three years the death-rate was based on an estimated population. It was, however, lower than in 1901 and 1900 (census year), and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

[1] In 1900 a part of Williamstown was annexed to North Adams.

*Sexes.* — The number of deaths of males was 22,243, or 51.27 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 21,142, or 48.73 per cent. There were 25 in which the sex was not stated in the returns.

*Ages.* — The deaths by four groups of ages were as follows: —

| Ages. | Deaths 1905. | Percentages of All Deaths. 1905. | 1904. |
|---|---|---|---|
| Under 1 year, | 9,221 | 21.27 | 21.34 |
| 1 to 20 years, | 5,966 | 13.74 | 13.57 |
| 20 to 60 years, | 10,685 | 24.65 | 25.01 |
| 60 and over, | 17,489 | 40.34 | 40.08 |

*Infant Mortality.* — The deaths of infants under one year old were 9,221, or 21.27 per cent. of the total mortality, as compared with 21.34 per cent. in 1904; and this was the lowest rate of infant mortality during the period of twelve years since the law was enacted requiring these returns; that of the five years 1901–1905, respectively, constituted 21.6, 21.7, 21.38, 21.34 and 21.27 per cent. of the total mortality.

The deaths of children under five years old were 12,512, or 28.9 per cent. of the total mortality, as compared with 29 per cent. for the same age in 1904.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 59; in 1904 it was 15.

*Still-births.* — The number of still-births was 2,844, and when compared with the total mortality (still-births included), this was 6.1 per cent. of the total deaths and still-births combined. In 1904 the percentage was 6.2.

*Months and Quarters.* — The number of deaths in each quarter of the year is shown in the following table: —

| | Deaths 1905. | Percentages. 1905. | 1904. |
|---|---|---|---|
| First quarter, | 11,536 | 26.58 | 27.14 |
| Second quarter, | 10,372 | 23.89 | 23.71 |
| Third quarter, | 11,532 | 26.57 | 25.29 |
| Fourth quarter, | 9,968 | 22.96 | 23.86 |
| Total, | 43,408 | 100.00 | 100.00 |

These percentages differ but little from the mean of several years, which usually shows the highest mortality in the third quarter of the year. In 1899, 1901, 1903 and 1904 the highest mortality was in the first quarter. In 1905 the first and third quarters were practically the same.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 669 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

| | Deaths in Each Month. | Mean Daily Deaths per Month 1905. | Centesimal Ratio. | |
|---|---|---|---|---|
| | | | 1905. | 1904.[1] |
| January, | 3,859 | 124.5 | 104.7 | 108.5 |
| February, | 3,698 | 132.1 | 111.1 | 106.8 |
| March, | 3,979 | 128.4 | 108.0 | 112.0 |
| April, | 3,659 | 122.0 | 102.6 | 108.5 |
| May, | 3,613 | 116.5 | 98.0 | 95.8 |
| June, | 3,100 | 103.3 | 86.9 | 81.8 |
| July, | 3,945 | 127.3 | 107.1 | 97.0 |
| August, | 4,159 | 134.1 | 112.8 | 104.2 |
| September, | 3,428 | 114.3 | 96.1 | 100.5 |
| October, | 3,295 | 106.1 | 89.2 | 89.4 |
| November, | 3,270 | 109.0 | 91.7 | 95.7 |
| December, | 3,406 | 109.8 | 92.3 | 99.6 |
| Annual mean, | - | 118.9 | 100.0 | 100.0 |

[1] In ascertaining the mean daily deaths and the centesimal ratios, allowance was made for the fact that 1904 had 366 days.

The figures in the foregoing table indicate a departure in excess of the mean death-rate in the first four months of the year and in July and August, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1905, was 12.8 per cent. and those of February and March, 1905, were, respectively, 11.1 and 8 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1905, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mor-

tality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

*Death-rates of Cities and Large Towns.* — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the census population. They vary from a minimum of 8.7 in Wellesley to 20.8 per 1,000 in Hingham.

The following cities and towns had death-rates above 19 per 1,000 in 1905: Hingham, 20.8; Montague, 20.7; Stoughton, 20.6; Fall River, 20.2; Lowell, 20; Maynard, 20; Blackstone, 19.9; Newburyport, 19.8; Middleborough, 19.6; Lawrence, 19.6; Salem, 19.5.

Of the foregoing, Blackstone and Newburyport had death-rates above 19 per 1,000 in 1904.

The following cities and towns had death-rates less than 12 per 1,000 in 1905: Northampton, 11.9; Whitman, 11.7; Brookline, 11.5; Winchester, 11.2; Milton, 10.9; South Hadley, 10.5; Hudson, 9.7; Wellesley, 8.7; of these, Brookline, Wellesley and Whitman also had death-rates below 12 per 1,000 in 1904.

The following table presents the mean death-rates of cities over 25,000 population for the five census years 1870, 1875, 1880, 1885 and 1890, together with the death-rates for the years 1900 and 1905.

In all of these cities except 2 (Taunton and Newton) there appears to have been decided improvement. In Taunton, the death-rate for 1905 is somewhat higher than the mean; in Newton, it has remained the same.

*Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Five Census Years 1870, 1875, 1880, 1885, 1890, and for 1900 and 1905.*

| | Mean Death-rates, 1870, 1875, 1880, 1885 and 1890. | Death-rate, 1900. | Death-rate, 1905. | | Mean Death-rates, 1870, 1875, 1880, 1885 and 1890. | Death-rate, 1900. | Death-rate, 1905. |
|---|---|---|---|---|---|---|---|
| Boston, | 24.1 | 20.8 | 18.5 [1] | Brockton. | 16.2 | 13.8 | 12.7 |
| Worcester, | 19.7 | 18.8 | 17.4 [1] | Haverhill, | 17.8 | 15.2 | 15.5 |
| Fall River, | 23.4 | 21.0 | 20.2 | Salem, | 22.1 | 19.6 | 19.5 |
| Lowell, | 22.5 | 19.5 | 20.0 | Chelsea, | 19.7 | 19.1 | 18.4 [1] |
| Cambridge, | 19.9 | 16.8 | 15.5 | Malden, | 17.0 | 14.6 | 13.3 |
| Lynn, | 17.8 | 15.8 | 16.2 | Newton, | 13.1 | 14.9 | 13.1 |
| Lawrence, | 26.5 | 20.0 | 19.6 | Fitchburg, | 17.0 | 14.9 | 13.1 |
| New Bedford, | 20.9 | 20.6 | 17.2 | Taunton, | 19.5 | 21.1 | 21.8 [1] |
| Springfield, | 19.3 | 18.4 | 15.2 | Gloucester, | 21.8 | 14.6 | 14.8 |
| Somerville, | 18.2 | 15.7 | 14.0 | Quincy, | 18.7 | 14.4 | 13.1 |
| Holyoke, | 23.1 | 21.5 | 16.3 | Waltham, | 15.3 | 15.6 | 13.7 |

[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 15.9 in Chelsea, 16.8 in Boston, 17.9 in Taunton and 15.8 in Worcester.

*Causes of Death.* — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified ac-

cording to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the census population of the group for 1905, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 167.67 per 10,000 living, or, as usually stated, 16.77 per 1,000, was higher than that of the three preceding years, but considerably lower than the three preceding census years, viz., 1900, when the death-rate was 18.26; 1895, when it was 19.18; and 1890, when it was 21.38. The population comprised in these returns constitutes over 86 per cent. of that of the whole State.

The decline in the general death-rate is chiefly due to a decrease in the relative number of deaths from infectious diseases, and especially from those which are usually considered preventable.

The death-rates from each of the following causes was less than that of 1904: consumption, measles, diphtheria, erysipelas and dysentery. Those of smallpox, measles, scarlet fever, diphtheria and dysentery were also less than the death-rates from the same causes in any of the last five years, with the exception of scarlet fever in 1904 and dysentery in 1903, when the death-rate from each of these was the same as in 1905.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and also shows that this combined death-rate in 1905 was less, with the exception of 1904, than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the eleven years (1895–1905) in the cities and towns included in this report (about six-sevenths of the total population of the State) was as follows: —

*Combined Death-rate from Eight Principal Infective Diseases.*

| YEAR. | Combined Death-rate per 10,000. | YEAR. | Combined Death-rate per 10,000. |
|---|---|---|---|
| 1895, | 46.4 | 1901, | 33.5 |
| 1896, | 46.8 | 1902, | 30.9 |
| 1897, | 39.7 | 1903, | 30.7 |
| 1898, | 36.3 | 1904, | 27.0 |
| 1899, | 35.2 | 1905, | 28.0 |
| 1900, | 40.7 | | |

The death-rate from consumption was lower than during 1904, being 16.01 in 1905, 16.05 in 1904, 15.66 in 1903 and 16.38 in 1902.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 668.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past eleven years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5 and 16.7 in the eleven succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7 and 46.6 in the same years.

These all combined constituted the greater part of the total mortality in each of the twelve years 1894–1905, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

*Population of Cities and Large Towns. (Census of 1905.)*

| Reporting Cities and Towns. | Population for 1905. | Reporting Cities and Towns. | Population for 1905. |
|---|---|---|---|
| Abington, | 5,081 | Chicopee, | 20,191 |
| Adams, | 12,486 | Clinton, | 13,105 |
| Amesbury, | 8,840 | Concord, | 5,421 |
| Amherst, | 5,318 | Danvers, | 9,058 |
| Andover, | 6,632 | Dedham, | 7,774 |
| Arlington, | 9,668 | Easthampton, | 6,808 |
| Athol, | 7,197 | Easton, | 4,909 |
| Attleborough, | 12,702 | Everett, | 29,111 |
| Beverly, | 15,223 | Fall River, | 105,762 |
| Blackstone, | 5,786 | Fitchburg, | 33,021 |
| Boston, | 595,380 | Framingham, | 11,548 |
| Braintree, | 6,879 | Franklin, | 5.244 |
| Bridgewater, | 6,754 | Gardner, | 12,012 |
| Brockton, | 47,794 | Gloucester, | 26,011 |
| Brookline, | 23,436 | Grafton, | 5,052 |
| Cambridge, | 97,434 | Great Barrington, | 6,152 |
| Chelsea, | 37,289 | Greenfield, | 9,156 |

TABLE I. — *Concluded.*

| Reporting Cities and Towns. | Population for 1905. | Reporting Cities and Towns. | Population for 1905. |
|---|---|---|---|
| Haverhill, | 37,830 | Quincy, | 28,076 |
| Hingham, | 4,819 | Reading, | 5,682 |
| Holyoke, | 49,934 | Revere, | 12,659 |
| Hudson, | 6,217 | Rockland, | 6,287 |
| Hyde Park, | 14,510 | Salem, | 37,627 |
| Ipswich, | 5,205 | Saugus, | 6,253 |
| Lawrence, | 70,050 | Somerville, | 69,272 |
| Leominster. | 14,297 | Southbridge, | 11,000 |
| Lowell, | 94,889 | South Hadley, | 5,054 |
| Lynn, | 77,042 | Spencer, | 7,121 |
| Malden, | 38,037 | Springfield, | 73,540 |
| Marblehead, | 7,209 | Stoneham, | 6,332 |
| Marlborough, | 14,073 | Stoughton, | 5,959 |
| Maynard, | 5,811 | Swampscott, | 5,141 |
| Medford, | 19,686 | Taunton, | 30,967 |
| Melrose, | 14,295 | Wakefield, | 10,268 |
| Methuen, | 8,676 | Waltham, | 26,282 |
| Middleborough, | 6,888 | Ware, | 8,594 |
| Milford, | 12,105 | Watertown, | 11,258 |
| Milton, | 7,054 | Webster, | 10,018 |
| Montague, | 7,015 | Wellesley, | 6,189 |
| Natick, | 9,609 | Westborough, | 5,878 |
| New Bedford, | 74,362 | Westfield, | 13,611 |
| Newburyport, | 14,675 | West Springfield, | 8,101 |
| Newton, | 36,827 | Weymouth, | 11,585 |
| North Adams, | 22,150 | Whitman, | 6,521 |
| Northampton, | 19,957 | Williamstown, | 4,425 |
| North Attleborough, | 7,878 | Winchendon, | 5,963 |
| Northbridge, | 7,400 | Winchester, | 8,242 |
| Norwood, | 6,731 | Winthrop, | 7,034 |
| Orange, | 5,578 | Woburn, | 14,402 |
| Palmer, | 7,755 | Worcester, | 128,135 |
| Peabody, | 13,098 | | |
| Pittsfield, | 25,001 | Total, | 2,588,962 |
| Plymouth, | 11,119 | | |

## Table II.

*Total Deaths, Deaths by Sexes and Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each by the Census of 1905, with General Death-rates.*

| | Total Deaths. | Males. | Females. | Sex Unknown. | Still-births. | Deaths under 1. | 1-2. | 2-3. | 3-4. | 4-5. | 5-10. | 10-15. | 15-20. | 20-30. | 30-40. | 40-50. | 50-60. | 60-70. | 70-80. | Over 80. | Age Unknown. | Rate per 1,000. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abington, | 84 | 38 | 46 | - | 6 | 16 | 1 | - | 1 | - | 1 | 1 | 3 | 2 | 8 | 6 | 7 | 19 | 6 | 13 | - | 16.53 |
| Adams, | 220 | 107 | 113 | - | 15 | 66 | 18 | 5 | 3 | 1 | 2 | 3 | 6 | 22 | 16 | 14 | 17 | 19 | 16 | 12 | - | 17.62 |
| Amesbury, | 136 | 65 | 71 | - | 7 | 25 | 6 | 2 | 1 | 1 | 1 | 3 | - | 11 | 7 | 8 | 7 | 26 | 20 | 18 | - | 15.38 |
| Amherst, | 77 | 37 | 40 | - | 1 | 7 | - | - | - | 1 | - | - | 2 | 5 | 3 | 6 | 5 | 13 | 20 | 15 | - | 14.12 |
| Andover, | 113 | 53 | 60 | - | 4 | 9 | 1 | 3 | 1 | - | 1 | - | 4 | 11 | 6 | 6 | 18 | 21 | 12 | 19 | 1 | 17.04 |
| Arlington, | 124 | 59 | 65 | - | 15 | 13 | 2 | 3 | 2 | - | 2 | 3 | 5 | 10 | 12 | 7 | 15 | 20 | 18 | 12 | - | 12.83 |
| Athol, | 127 | 65 | 62 | - | 8 | 20 | 3 | 4 | - | 1 | 2 | 1 | 3 | 9 | 8 | 4 | 7 | 18 | 29 | 13 | 5 | 17.65 |
| Attleborough, | 177 | 95 | 82 | - | 8 | 45 | 8 | 2 | 2 | 2 | 5 | 3 | 4 | 11 | 12 | 10 | 16 | 17 | 25 | 15 | - | 13.93 |
| Beverly, | 262 | 130 | 132 | - | 18 | 28 | 5 | 3 | 4 | 2 | 7 | 5 | 3 | 18 | 27 | 23 | 26 | 50 | 41 | 20 | - | 17.21 |
| Blackstone, | 115 | 71 | 44 | - | 4 | 25 | 4 | 3 | 1 | 1 | 6 | 3 | 3 | 8 | 9 | 8 | 12 | 12 | 14 | 6 | - | 19.88 |
| Boston,[1] | 11,007 | 5,839 | 5,168 | - | 670 | 2,186 | 431 | 213 | 112 | 82 | 255 | 155 | 221 | 888 | 1,183 | 1,162 | 1,286 | 1,321 | 978 | 534 | - | 16.77[2] |
| Braintree, | 92 | 49 | 43 | - | 10 | 15 | 5 | 1 | 1 | 1 | 4 | 6 | 3 | 6 | 7 | 5 | 5 | 11 | 9 | 13 | - | 13.37 |
| Bridgewater,[3] | 86 | 42 | 44 | - | 1 | 13 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 4 | 4 | 4 | 10 | 13 | 21 | 6 | - | 12.73 |
| Brockton, | 609 | 308 | 295 | 6 | 45 | 96 | 16 | 10 | 4 | 6 | 11 | 11 | 20 | 40 | 62 | 54 | 66 | 64 | 76 | 37 | 36 | 12.74 |
| Brookline, | 259 | 115 | 144 | - | 15 | 37 | 5 | 4 | 2 | - | 3 | 5 | - | 11 | 25 | 22 | 37 | 44 | 38 | 26 | - | 11.51 |
| Cambridge, | 1,511 | 735 | 776 | - | 92 | 322 | 51 | 38 | 25 | 6 | 29 | 25 | 27 | 130 | 136 | 125 | 180 | 171 | 136 | 109 | 1 | 15.51 |
| Chelsea,[4] | 685 | 404 | 281 | - | 48 | 147 | 30 | 11 | 5 | 3 | 13 | 9 | 11 | 45 | 49 | 59 | 66 | 101 | 88 | 48 | - | 15.85[2] |
| Chicopee, | 356 | 186 | 170 | - | 34 | 125 | 24 | 12 | 3 | 3 | 7 | 4 | 4 | 23 | 22 | 22 | 26 | 37 | 31 | 13 | - | 17.68 |
| Clinton, | 212 | 99 | 113 | - | 13 | 51 | 2 | 4 | 1 | 2 | 4 | 4 | 5 | 25 | 20 | 21 | 18 | 26 | 19 | 10 | - | 16.17 |
| Concord, | 70 | 42 | 28 | - | - | 6 | 1 | 1 | 1 | - | - | 2 | 6 | 7 | 6 | 4 | 9 | 7 | 10 | 10 | - | 12.91 |
| Danvers,[5] | 120 | 64 | 56 | - | 10 | 12 | 4 | 3 | - | 3 | 2 | 4 | 3 | 6 | 6 | 14 | 12 | 17 | 20 | 14 | - | 13.24 |
| Dedham, | 126 | 56 | 70 | - | 5 | 21 | 3 | - | 2 | - | 3 | 2 | 1 | 9 | 9 | 10 | 13 | 16 | 18 | 19 | - | 16.21 |
| Easthampton, | 90 | 35 | 55 | - | 7 | 22 | 2 | 3 | - | 1 | 5 | 2 | - | 9 | 1 | 4 | 8 | 13 | 12 | 8 | - | 13.22 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Easton, | 75 | 43 | 32 | - | 2 | 5 | - | 3 | - | 2 | - | - | - | 10 | 5 | 8 | 8 | 8 | 17 | 9 | - | 15.28 |
| Everett, | 402 | 204 | 197 | 1 | 33 | 95 | 10 | 13 | 2 | 1 | 14 | 5 | 7 | 29 | 33 | 27 | 52 | 45 | 46 | 23 | - | 13.81 |
| Fall River, | 2,139 | 1,107 | 1,032 | - | 193 | 809 | 81 | 79 | 63 | 70 | 76 | 64 | 58 | 159 | 132 | 157 | 110 | 148 | 97 | 41 | - | 20.22 |
| Fitchburg, | 452 | 224 | 228 | - | 36 | 124 | 19 | 6 | 5 | 3 | 4 | 5 | 11 | 36 | 26 | 36 | 44 | 59 | 43 | 30 | 1 | 13.08 |
| Framingham, | 200 | 96 | 104 | - | 5 | 26 | 3 | 3 | 1 | 1 | 3 | 3 | 6 | 16 | 18 | 12 | 17 | 26 | 37 | 30 | 3 | 17.32 |
| Franklin, | 84 | 38 | 46 | - | 4 | 15 | 4 | - | 1 | - | 3 | 3 | 3 | 5 | 4 | 5 | 9 | 11 | 14 | 7 | - | 16.01 |
| Gardner, | 171 | 91 | 79 | 1 | 17 | 53 | 10 | 2 | 3 | 1 | 3 | 1 | 1 | 5 | 7 | 12 | 18 | 23 | 20 | 12 | - | 14.24 |
| Gloucester, | 385 | 201 | 184 | - | 36 | 76 | 19 | 5 | 2 | 3 | 8 | 8 | 6 | 34 | 34 | 25 | 36 | 48 | 46 | 30 | 2 | 14.80 |
| Grafton, | 89 | 45 | 44 | - | 3 | 16 | 4 | 2 | 1 | - | 2 | - | 1 | 1 | 7 | 11 | 9 | 12 | 16 | 7 | - | 17.62 |
| Great Barrington, | 96 | 55 | 41 | - | 2 | 16 | 5 | 1 | 1 | 3 | 1 | 3 | 4 | 7 | 7 | 13 | 5 | 11 | 11 | 8 | - | 15.60 |
| Greenfield, | 161 | 93 | 68 | - | 8 | 29 | 6 | 3 | 2 | - | 2 | 1 | 1 | 16 | 9 | 8 | 13 | 25 | 24 | 22 | - | 17.58 |
| Haverhill, | 588 | 268 | 320 | - | 58 | 81 | 25 | 10 | 5 | 3 | 9 | 12 | 16 | 46 | 63 | 49 | 81 | 63 | 85 | 40 | - | 15.54 |
| Hingham, | 100 | 56 | 43 | 1 | 2 | 10 | 1 | - | - | - | 2 | 1 | - | 2 | 7 | 7 | 12 | 12 | 27 | 19 | - | 20.75 |
| Holyoke, | 816 | 397 | 419 | - | 89 | 251 | 34 | 26 | 19 | 12 | 28 | 13 | 27 | 62 | 65 | 64 | 68 | 67 | 54 | 26 | - | 16.34 |
| Hudson, | 60 | 25 | 35 | - | 5 | 6 | 3 | - | - | 1 | - | 3 | 1 | 4 | 4 | 4 | 13 | 7 | 13 | 1 | - | 9.65 |
| Hyde Park, | 196 | 97 | 93 | 6 | 10 | 43 | 9 | 3 | 1 | - | 5 | 5 | 1 | 6 | 17 | 15 | 21 | 28 | 24 | 18 | - | 13.51 |
| Ipswich, | 84 | 43 | 41 | - | 4 | 20 | 2 | - | - | - | - | 1 | 4 | 2 | 2 | 7 | 6 | 10 | 15 | 15 | - | 16.14 |
| Lawrence, | 1,372 | 699 | 673 | - | 105 | 397 | 90 | 45 | 23 | 7 | 43 | 29 | 48 | 91 | 113 | 118 | 92 | 135 | 100 | 41 | - | 19.59 |
| Leominster, | 245 | 130 | 115 | - | 10 | 44 | 7 | 2 | 1 | - | 6 | 2 | 6 | 20 | 19 | 12 | 39 | 31 | 27 | 29 | - | 17.13 |
| Lowell, | 1,899 | 954 | 945 | - | 135 | 495 | 101 | 37 | 30 | 25 | 41 | 28 | 44 | 155 | 171 | 156 | 193 | 198 | 148 | 77 | - | 20.01 |
| Lynn, | 1,249 | 644 | 605 | - | 78 | 235 | 44 | 14 | 12 | 9 | 29 | 20 | 29 | 108 | 114 | 103 | 154 | 158 | 134 | 84 | 2 | 16.21 |
| Malden, | 506 | 253 | 253 | - | 33 | 97 | 18 | 9 | 3 | 3 | 7 | 11 | 8 | 36 | 27 | 50 | 52 | 57 | 84 | 44 | - | 13.30 |
| Marblehead, | 132 | 64 | 68 | - | 6 | 11 | 1 | 1 | 1 | 4 | 1 | 2 | 3 | 2 | 8 | 11 | 12 | 17 | 26 | 32 | - | 18.31 |
| Marlborough, | 209 | 113 | 96 | - | 15 | 32 | 4 | - | - | 2 | 6 | 3 | 7 | 23 | 17 | 16 | 30 | 25 | 24 | 20 | - | 14.85 |
| Maynard, | 116 | 65 | 46 | 5 | 12 | 35 | 6 | 4 | - | 1 | 2 | 4 | 1 | 14 | 9 | 8 | 9 | 9 | 10 | 4 | - | 19.96 |
| Medford, | 266 | 114 | 152 | - | 11 | 50 | 2 | 2 | 2 | 1 | 3 | 4 | 4 | 13 | 16 | 19 | 27 | 49 | 40 | 33 | 1 | 13.51 |
| Melrose, | 209 | 91 | 118 | - | 10 | 23 | 6 | 1 | 1 | 2 | 3 | 4 | 7 | 17 | 20 | 12 | 23 | 36 | 25 | 29 | - | 14.62 |
| Methuen, | 144 | 75 | 69 | - | 6 | 24 | 4 | 1 | - | 1 | 6 | 4 | 7 | 6 | 9 | 11 | 17 | 23 | 24 | 7 | - | 16.60 |
| Middleborough, | 136 | 63 | 73 | - | 1 | 17 | 3 | - | 2 | - | 2 | 1 | 2 | 6 | 7 | 12 | 15 | 26 | 24 | 17 | 2 | 19.75 |
| Milford, | 192 | 97 | 95 | - | 18 | 30 | 10 | 2 | 3 | 5 | 2 | - | 5 | 11 | 21 | 14 | 14 | 29 | 30 | 16 | - | 15.86 |
| Milton, | 77 | 43 | 34 | - | 3 | 4 | 1 | - | 1 | 1 | 1 | 4 | 2 | 6 | 3 | 12 | 4 | 21 | 11 | 6 | - | 10.92 |

[1] Non-residents, 1,020, included. [2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] State Farm, deaths at, 84, not included. [4] Soldiers' Home, 94, included. [5] Insane Asylum, 146, not included.

TABLE II. — *Concluded.*

| | Total Deaths. | Males. | Females. | Sex Unknown. | Still-births. | Deaths under 1. | 1-2. | 2-3. | 3-4. | 4-5. | 5-10. | 10-15. | 15-20. | 20-30. | 30-40. | 40-50. | 50-60. | 60-70. | 70-80. | Over 80. | Age Unknown. | Rate per 1,000. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montague, | 145 | 79 | 66 | - | 13 | 52 | 3 | - | - | 2 | 2 | 6 | 14 | 7 | 8 | 11 | 19 | 12 | 9 | - | - | 20.67 |
| Natick, | 161 | 81 | 80 | - | 6 | 12 | 2 | - | 2 | 1 | 3 | 2 | 2 | 10 | 6 | 17 | 19 | 35 | 31 | 19 | - | 16.75 |
| New Bedford, | 1,275 | 664 | 611 | - | 97 | 401 | 62 | 25 | 18 | 7 | 22 | 20 | 29 | 81 | 79 | 98 | 101 | 147 | 113 | 72 | - | 17.15 |
| Newburyport, | 290 | 146 | 144 | - | 18 | 41 | 9 | 7 | - | 1 | 4 | 1 | 4 | 15 | 20 | 19 | 40 | 41 | 44 | 44 | - | 19.76 |
| Newton, | 484 | 223 | 261 | - | 24 | 88 | 13 | 11 | 1 | - | 11 | 13 | 9 | 35 | 24 | 20 | 38 | 82 | 80 | 59 | - | 13.14 |
| North Adams, | 301 | 152 | 149 | - | 32 | 57 | 7 | 8 | 5 | 2 | 8 | 6 | 7 | 23 | 25 | 24 | 35 | 42 | 31 | 21 | - | 13.59 |
| Northampton,[1] | 328 | 187 | 141 | - | 20 | 55 | 10 | 1 | 2 | - | 4 | 3 | 5 | 14 | 22 | 29 | 37 | 62 | 54 | 30 | - | 11.88[2] |
| North Attleborough, | 132 | 69 | 63 | - | 6 | 18 | 3 | 5 | - | 2 | 1 | 2 | 1 | 12 | 8 | 10 | 17 | 18 | 23 | 12 | - | 16.76 |
| Northbridge, | 115 | 60 | 55 | - | 10 | 36 | 10 | 3 | - | 2 | - | 2 | 2 | 9 | 10 | 12 | 9 | 9 | 9 | 2 | - | 15.54 |
| Norwood, | 84 | 43 | 41 | - | 10 | 24 | - | 1 | 3 | - | 4 | - | 2 | 2 | 3 | 6 | 8 | 8 | 9 | 14 | - | 12.48 |
| Orange, | 91 | 46 | 45 | - | 4 | 19 | 3 | 2 | - | - | 2 | 1 | 2 | 4 | - | 7 | 4 | 17 | 16 | 14 | - | 16.31 |
| Palmer, | 120 | 60 | 60 | - | 10 | 54 | 5 | 1 | 2 | 1 | - | 1 | 5 | 5 | 5 | 4 | 8 | 12 | 11 | 6 | - | 15.47 |
| Peabody, | 195 | 87 | 108 | - | 13 | 23 | 7 | 2 | 3 | - | 3 | 4 | 4 | 20 | 22 | 18 | 24 | 17 | 25 | 21 | - | 14.89 |
| Pittsfield, | 421 | 218 | 203 | - | 19 | 58 | 7 | 6 | 1 | 1 | 11 | 3 | 9 | 42 | 32 | 45 | 44 | 64 | 58 | 39 | 1 | 16.84 |
| Plymouth, | 199 | 98 | 101 | - | 5 | 33 | 4 | 4 | 1 | 1 | 1 | 1 | 5 | 13 | 10 | 15 | 18 | 25 | 33 | 35 | - | 17.90 |
| Quincy, | 368 | 196 | 172 | - | 26 | 81 | 16 | 7 | 5 | 2 | 8 | 6 | 10 | 28 | 31 | 28 | 37 | 44 | 45 | 20 | - | 13.11 |
| Reading, | 78 | 34 | 44 | - | 1 | 10 | - | 2 | 1 | - | 1 | 2 | 1 | 5 | 6 | 5 | 11 | 8 | 13 | 13 | - | 13.73 |
| Revere, | 186 | 92 | 94 | - | 9 | 33 | 5 | - | - | 3 | 3 | 5 | 12 | 22 | 18 | 28 | 21 | 16 | 16 | 4 | - | 14.69 |
| Rockland, | 102 | 51 | 51 | - | 2 | 9 | 4 | - | 1 | - | - | 1 | 7 | 1 | 7 | 9 | 11 | 17 | 19 | 15 | 1 | 16.22 |
| Salem, | 735 | 365 | 369 | 1 | 42 | 190 | 42 | 13 | 11 | 7 | 19 | 12 | 16 | 49 | 48 | 40 | 64 | 81 | 94 | 49 | - | 19.53 |
| Saugus, | 115 | 75 | 40 | - | 6 | 35 | 2 | 1 | 1 | 6 | 2 | 2 | 7 | 7 | 5 | 11 | 20 | 15 | 1 | - | - | 18.39 |
| Somerville, | 968 | 453 | 515 | - | 60 | 157 | 23 | 10 | 18 | 11 | 29 | 9 | 17 | 67 | 68 | 80 | 98 | 132 | 172 | 83 | - | 13.97 |
| Southbridge, | 192 | 109 | 83 | - | 8 | 55 | 11 | 5 | 9 | 10 | 14 | 6 | 3 | 14 | 8 | 5 | 10 | 17 | 16 | 9 | - | 17.45 |
| South Hadley, | 53 | 20 | 33 | - | 3 | 6 | 4 | 1 | - | - | 1 | 2 | 1 | 1 | 1 | 3 | 6 | 11 | 9 | 7 | - | 10.48 |
| Spencer, | 110 | 59 | 51 | - | 9 | 16 | 2 | 2 | 1 | - | 3 | 4 | 3 | 8 | 7 | 4 | 10 | 23 | 16 | 11 | - | 15.45 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Springfield, | 1,120 | 577 | 543 | - | 71 | 198 | 35 | 8 | 15 | 8 | 35 | 17 | 28 | 82 | 118 | 91 | 106 | 146 | 144 | 88 | 1 | 15.23 |
| Stoneham, | 110 | 52 | 58 | - | 7 | 7 | 4 | 1 | 1 | - | 3 | 2 | 1 | 6 | 8 | 8 | 13 | 20 | 23 | 13 | - | 17.37 |
| Stoughton, | 123 | 59 | 64 | - | 8 | 19 | 1 | 1 | 1 | - | - | 2 | 4 | 8 | 9 | 12 | 13 | 12 | 21 | 20 | - | 20.64 |
| Swampscott, | 74 | 36 | 38 | - | 1 | 5 | 4 | - | - | - | 3 | 1 | 4 | 3 | 9 | 5 | 7 | 14 | 9 | 10 | - | 14.39 |
| Taunton,[3] | 676 | 353 | 323 | - | 35 | 150 | 29 | 10 | 4 | 4 | 10 | 10 | 8 | 45 | 47 | 66 | 70 | 86 | 75 | 61 | 1 | 17.89[2] |
| Wakefield, | 154 | 84 | 70 | - | 9 | 19 | 7 | 1 | 1 | - | 1 | 1 | 3 | 15 | 10 | 11 | 16 | 21 | 31 | 17 | - | 15.00 |
| Waltham, | 361 | 162 | 199 | - | 22 | 37 | 6 | 5 | 3 | 3 | 14 | 17 | 14 | 42 | 29 | 26 | 37 | 43 | 55 | 30 | - | 13.74 |
| Ware, | 127 | 71 | 56 | - | 8 | 35 | 8 | 2 | 2 | 1 | 3 | 1 | 4 | 11 | 10 | 7 | 10 | 7 | 17 | 9 | - | 14.78 |
| Watertown, | 146 | 66 | 80 | - | 21 | 22 | 5 | 2 | 3 | 5 | 3 | - | 4 | 14 | 9 | 7 | 17 | 27 | 12 | 16 | - | 12.97 |
| Webster, | 159 | 86 | 73 | - | 20 | 50 | 6 | 4 | 3 | 1 | 4 | 4 | 7 | 16 | 7 | 10 | 9 | 17 | 12 | 9 | - | 15.87 |
| Wellesley, | 54 | 24 | 30 | - | 4 | 6 | - | - | 1 | - | 1 | 1 | 2 | 2 | 5 | 5 | 10 | 4 | 6 | 11 | - | 8.73 |
| Westborough,[4] | 196 | 106 | 90 | - | - | 3 | 1 | - | 1 | - | 1 | - | 4 | 11 | 16 | 28 | 31 | 33 | 48 | 19 | - | 13.38[2] |
| Westfield, | 203 | 113 | 90 | - | 19 | 27 | 9 | 4 | - | 1 | 5 | 3 | 4 | 17 | 22 | 17 | 14 | 28 | 28 | 24 | - | 14.91 |
| West Springfield, | 110 | 59 | 51 | - | 8 | 24 | - | - | 1 | - | 4 | 2 | 1 | 16 | 12 | 7 | 3 | 16 | 16 | 8 | - | 13.58 |
| Weymouth, | 184 | 96 | 88 | - | 11 | 20 | 3 | 3 | 1 | 1 | - | 3 | 3 | 6 | 17 | 18 | 18 | 35 | 35 | 20 | 1 | 15.88 |
| Whitman, | 76 | 42 | 34 | - | 1 | 5 | 3 | - | 2 | 2 | 1 | 1 | 2 | 4 | 9 | 4 | 8 | 12 | 15 | 8 | - | 11.65 |
| Williamstown, | 59 | 26 | 33 | - | 1 | 10 | 5 | 1 | 2 | 1 | 1 | - | - | 1 | 4 | 3 | 6 | 5 | 10 | 10 | - | 13.33 |
| Winchendon, | 80 | 41 | 39 | - | 3 | 18 | 3 | 2 | 1 | 1 | 2 | - | - | 3 | 6 | 4 | 8 | 11 | 13 | 8 | - | 13.48 |
| Winchester, | 92 | 40 | 48 | 4 | 6 | 18 | 1 | 1 | - | - | 1 | - | 2 | 3 | 6 | 10 | 6 | 9 | 16 | 19 | - | 11.16 |
| Winthrop, | 100 | 46 | 54 | - | 5 | 12 | 3 | 3 | - | - | 1 | - | 2 | 3 | 10 | 9 | 14 | 19 | 12 | 12 | - | 14.22 |
| Woburn, | 223 | 103 | 120 | - | 14 | 31 | 6 | 5 | 2 | 3 | 2 | - | 7 | 9 | 25 | 16 | 25 | 39 | 34 | 19 | - | 15.48 |
| Worcester,[5] | 2,227 | 1.152 | 1,075 | - | 136 | 464 | 60 | 24 | 17 | 18 | 38 | 38 | 49 | 194 | 191 | 219 | 243 | 261 | 251 | 157 | - | 15.76[2] |
| | 43,410 | 22,243 | 21,142 | 25 | 2,844 | 9,221 | 1,610 | 797 | 498 | 386 | 966 | 713 | 986 | 3,263 | 3,679 | 3,743 | 4,462 | 5,288 | 4,786 | 2,953 | 59 | 16.77 |

[1] Insane Asylum, 73, non-residents, 18, included.
[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] Insane Asylum, 122, included. [4] Insane Asylum, 124, included. [5] Insane Asylum and Insane Hospital, 207, included.

## TABLE III.

*Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each by the Census of 1905.*

| | Consumption. | Smallpox. | Measles. | Scarlet Fever. | Diphtheria. | Whooping Cough. | Typhoid Fever. | Cerebro-spinal Meningitis. | Erysipelas. | Puerperal Fever. | Influenza. | Malarial Fever. | Cholera Infantum. | Dysentery. | Diarrhoea and Cholera Morbus. | Pneumonia. | Bronchitis. | Diseases of the Heart. | Diseases of the Brain and Spinal Cord. | Diseases of the Kidneys. | Cancer. | Suicide. | Accident. | Unknown or Ill-defined Causes. | All Other Causes. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abington, | 10 | - | - | 1 | - | - | 1 | 1 | - | - | - | 1 | 4 | 1 | - | 6 | 1 | 11 | 1 | 4 | 2 | - | 1 | - | 39 |
| Adams, | 37 | - | 3 | 2 | 1 | 6 | 9 | 9 | 1 | 2 | 7 | 2 | 34 | 2 | 2 | 16 | 5 | 18 | 21 | 12 | 4 | 3 | 5 | - | 19 |
| Amesbury, | 19 | - | - | - | - | - | 3 | - | - | - | 3 | - | 4 | 6 | 1 | 17 | 3 | 13 | 27 | 14 | 4 | - | 5 | 8 | 9 |
| Amherst, | 2 | - | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 1 | 3 | 13 | 4 | 4 | 6 | 1 | 1 | - | 40 |
| Andover, | 13 | - | - | 1 | 1 | - | 4 | - | - | - | - | - | 3 | 2 | - | 10 | 5 | 19 | 17 | 1 | 10 | - | 4 | - | 28 |
| Arlington, | 9 | - | - | 1 | 1 | - | - | 2 | 1 | - | - | - | 2 | 1 | - | 16 | 2 | 10 | - | 9 | 8 | 2 | 5 | - | 55 |
| Athol, | 7 | - | - | - | 2 | 2 | 1 | 6 | - | 1 | 1 | 1 | 7 | - | 2 | 22 | 2 | 12 | 17 | 4 | 7 | 1 | 4 | 1 | 27 |
| Attleborough, | 22 | - | 1 | 1 | 2 | 2 | 1 | 4 | - | - | 2 | - | 2 | 1 | 1 | 14 | 7 | 20 | 27 | 8 | 7 | 1 | 7 | - | 47 |
| Beverly, | 18 | - | - | 1 | 7 | - | 6 | 5 | - | - | - | - | 9 | - | 1 | 26 | 5 | 36 | 19 | 18 | 18 | 4 | 14 | - | 74 |
| Blackstone, | 5 | - | 3 | - | - | - | 2 | - | 2 | - | 1 | - | 8 | 5 | 1 | 18 | - | 11 | 3 | 5 | 1 | - | 8 | - | 42 |
| Boston, | 1,224 | 1 | 54 | 44 | 132 | 29 | 117 | 142 | 47 | 26 | 73 | 2 | 182 | 15 | 481 | 1,274 | 277 | 1,082 | 681 | 568 | 628 | 82 | 544 | 109 | 3,179 |
| Braintree, | 8 | - | - | - | - | - | 1 | 2 | - | - | 1 | - | 6 | 4 | - | 10 | 1 | 10 | 13 | 5 | 3 | - | 6 | - | 22 |
| Bridgewater, | 7 | - | - | - | - | 1 | - | 1 | - | - | 1 | - | - | - | 3 | 7 | 1 | 9 | 5 | 6 | 10 | 1 | 2 | 14 | 18 |
| Brockton, | 86 | - | - | 4 | - | 5 | 9 | 17 | 1 | 3 | 8 | 1 | 14 | 5 | - | 44 | 9 | 68 | 38 | 40 | 16 | 2 | 70 | 2 | 166 |
| Brookline, | 16 | - | - | 1 | 2 | - | - | 5 | - | - | 3 | - | - | - | 1 | 16 | 10 | 63 | 19 | 18 | 28 | 1 | 3 | - | 78 |
| Cambridge, | 171 | - | 5 | 4 | 27 | 14 | 19 | 20 | 5 | 3 | 9 | - | 39 | 4 | 63 | 188 | 27 | 158 | 178 | 80 | 75 | 10 | 55 | 77 | 284 |
| Chelsea, | 55 | - | - | 1 | 3 | - | 6 | 6 | 1 | 3 | 11 | 1 | 18 | 1 | 2 | 52 | 17 | 101 | 53 | 34 | 29 | 3 | 11 | - | 277 |
| Chicopee, | 25 | - | 2 | - | 11 | 1 | 1 | 2 | 1 | 1 | 5 | 2 | 30 | 3 | 5 | 38 | 6 | 22 | 49 | 17 | 7 | 1 | 10 | - | 117 |
| Clinton, | 15 | - | - | - | 2 | - | 4 | 1 | 1 | - | - | - | 5 | 2 | 6 | 16 | 5 | 21 | - | 6 | 14 | - | 8 | 2 | 104 |
| Concord, | 10 | - | - | - | - | - | 3 | - | 1 | - | 2 | - | 1 | - | - | 5 | 3 | 10 | 2 | 6 | 2 | 3 | 4 | - | 18 |
| Danvers, | 12 | - | - | - | 5 | - | - | 6 | - | - | - | - | - | - | 5 | 13 | 3 | 12 | 2 | 8 | 5 | - | 1 | - | 48 |
| Dedham, | 13 | - | - | - | - | - | 1 | - | - | - | - | - | 2 | - | 3 | 20 | 3 | 19 | 19 | 9 | 2 | - | 4 | - | 31 |
| Easthampton, | 5 | - | - | - | 1 | - | 1 | 5 | - | - | - | - | 7 | - | - | 11 | 6 | 7 | 3 | 3 | 3 | - | 3 | - | 35 |
| Easton, | 7 | - | - | - | - | 1 | 2 | - | - | - | - | - | - | - | - | 8 | - | 12 | 11 | 6 | 6 | 1 | 2 | - | 19 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Everett, | 46 | 1 | 1 | 1 | 15 | - | 6 | 8 | 2 | - | 10 | - | 5 | - | 4 | 38 | 15 | 43 | 3 | 2 | 25 | - | 4 | 1 | 177 |
| Fall River, | 131 | - | 11 | 3 | 32 | 21 | 9 | 8 | 3 | 2 | 19 | 5 | 197 | 10 | 32 | 225 | 112 | 79 | 292 | 102 | 49 | 4 | 46 | 23 | 724 |
| Fitchburg, | 28 | - | 2 | - | 5 | 1 | 4 | 1 | 1 | 1 | 1 | - | 13 | 3 | - | 50 | 12 | 59 | 54 | 11 | 14 | 8 | 21 | 10 | 153 |
| Framingham, | 9 | - | - | 1 | 1 | 1 | 3 | 2 | 1 | - | - | - | 2 | - | 4 | 16 | 2 | 32 | 22 | 4 | 8 | 3 | 15 | - | 74 |
| Franklin, | 6 | - | - | - | - | - | - | 1 | - | 1 | - | - | 5 | - | - | 14 | 2 | 10 | 5 | - | 5 | - | 1 | - | 34 |
| Gardner, | 14 | - | 1 | - | 1 | 1 | 1 | 2 | - | - | 5 | - | 4 | 1 | - | 16 | 3 | 12 | 21 | 12 | 3 | 3 | 1 | - | 70 |
| Gloucester, | 24 | - | - | - | 10 | 1 | 15 | 4 | - | 1 | 1 | - | 17 | 2 | - | 24 | 10 | 30 | 2 | 14 | 20 | 2 | 11 | 1 | 196 |
| Grafton, | 3 | - | 2 | - | 1 | - | 3 | - | - | - | - | - | 4 | - | 1 | 12 | 2 | 9 | - | - | 6 | 1 | 1 | - | 44 |
| Great Barrington, | 11 | - | - | 1 | 1 | 3 | 1 | - | - | - | 1 | - | 5 | 1 | - | 11 | - | 12 | 6 | 8 | 6 | 2 | - | - | 27 |
| Greenfield, | 12 | - | 1 | - | - | - | - | 3 | - | - | 1 | - | 2 | 1 | 5 | 12 | 4 | 15 | 19 | 17 | 11 | 4 | 11 | 9 | 34 |
| Haverhill, | 73 | - | 2 | - | 8 | 4 | 7 | 8 | 2 | - | 14 | - | 22 | 3 | - | 66 | 9 | 57 | 51 | 40 | 46 | 2 | 25 | 2 | 147 |
| Hingham, | 4 | - | - | 3 | - | - | 2 | 2 | - | - | - | - | - | - | 2 | 7 | 2 | 15 | 16 | 2 | 9 | - | 5 | - | 29 |
| Holyoke, | 77 | - | 3 | - | 19 | 5 | 4 | 17 | 7 | 2 | 5 | - | 44 | 1 | 34 | 105 | 25 | 61 | 91 | 44 | 28 | 5 | 3 | - | 236 |
| Hudson, | 6 | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | 8 | 2 | 15 | 5 | 4 | 5 | 1 | 1 | - | 11 |
| Hyde Park, | 17 | - | - | - | 2 | - | 2 | 5 | 1 | 1 | - | 1 | 11 | 2 | 3 | 23 | 2 | 17 | 21 | 10 | 7 | 2 | 13 | - | 54 |
| Ipswich, | 6 | - | - | - | - | - | 1 | - | - | - | - | - | 5 | 1 | - | 7 | 1 | 16 | - | - | 3 | - | 3 | - | 41 |
| Lawrence, | 118 | - | 26 | 10 | 8 | 1 | 15 | 48 | - | 1 | 8 | - | 140 | 6 | 16 | 191 | 41 | 91 | 159 | 83 | 54 | 3 | 27 | 90 | 234 |
| Leominster, | 21 | - | - | - | 4 | - | 2 | 6 | 1 | 1 | - | 5 | 5 | - | 1 | 26 | 1 | 36 | - | 19 | 19 | - | 13 | - | 85 |
| Lowell, | 170 | - | 6 | - | 20 | 14 | 17 | 61 | 2 | 8 | 6 | - | 104 | 5 | 162 | 175 | 71 | 198 | 222 | 92 | 64 | 10 | 52 | 6 | 431 |
| Lynn, | 108 | - | - | 1 | 9 | - | 16 | 36 | 3 | 2 | - | - | 30 | 3 | 8 | 167 | 18 | 134 | 174 | 77 | 66 | 7 | 48 | 5 | 336 |
| Malden, | 52 | - | - | - | 4 | 1 | 3 | 2 | 2 | - | - | - | 13 | 1 | 3 | 58 | 18 | 65 | 79 | 33 | 21 | 7 | 4 | - | 145 |
| Marblehead, | 8 | - | - | - | 2 | - | 2 | 4 | 2 | - | - | - | 2 | - | - | 4 | 3 | 20 | 18 | 9 | 5 | 1 | 3 | - | 54 |
| Marlborough, | 28 | - | - | - | - | - | 1 | 1 | 4 | - | - | - | 2 | 2 | 1 | 20 | 5 | 31 | 15 | 10 | 10 | - | 4 | 3 | 72 |
| Maynard, | 13 | - | - | - | 1 | - | 1 | 1 | - | - | 2 | - | 12 | 1 | 2 | 8 | 1 | 14 | 7 | 5 | 3 | 1 | 8 | - | 36 |
| Medford, | 8 | - | - | 2 | 2 | - | 3 | 1 | - | - | 2 | - | 1 | - | - | 33 | 7 | 24 | 1 | 20 | 25 | 1 | 2 | - | 134 |
| Melrose, | 20 | - | 5 | 1 | - | - | - | - | - | - | 1 | - | 2 | - | 5 | 8 | 5 | 37 | 24 | 16 | 20 | 2 | 7 | 2 | 54 |
| Methuen, | 10 | - | - | 2 | 3 | - | 6 | 8 | 1 | 1 | 5 | 4 | 10 | 2 | - | 9 | 2 | 10 | 8 | 13 | 6 | 1 | 15 | 5 | 23 |
| Middleborough, | 8 | - | - | - | 1 | - | 1 | 2 | 1 | - | - | - | 2 | - | - | 10 | 5 | 22 | 9 | 8 | 6 | 5 | 6 | - | 55 |
| Milford, | 18 | - | 1 | 1 | 1 | - | - | 3 | 2 | - | 1 | - | 4 | 7 | 7 | 23 | - | 21 | 29 | 14 | 9 | 2 | 4 | - | 45 |
| Milton, | 9 | - | - | - | - | - | 2 | - | - | - | - | - | - | 2 | - | 9 | 2 | 5 | 9 | 5 | 4 | 2 | 3 | - | 25 |
| Montague, | 16 | - | - | - | 2 | - | 3 | 6 | - | - | 4 | - | 7 | 4 | 2 | 5 | 6 | 14 | - | 10 | 1 | 1 | 4 | - | 60 |
| Natick, | 12 | - | - | - | 1 | 1 | - | - | - | - | - | - | 1 | 2 | - | 9 | 3 | 30 | 1 | 4 | 5 | 2 | 1 | - | 89 |
| New Bedford, | 122 | - | - | 2 | 27 | 2 | 4 | 2 | 3 | - | 4 | - | 64 | 1 | 3 | 131 | 32 | 124 | 53 | 73 | 44 | 5 | 5 | 1 | 573 |
| Newburyport, | 12 | - | - | - | 1 | - | 7 | 5 | - | - | 1 | - | 9 | - | 1 | 26 | 15 | 19 | 3 | 11 | 9 | 3 | 7 | - | 161 |

TABLE III. — *Concluded.*

| | Consumption. | Smallpox. | Measles. | Scarlet Fever. | Diphtheria. | Whooping Cough. | Typhoid Fever. | Cerebro-spinal Meningitis. | Erysipelas. | Puerperal Fever. | Influenza. | Malarial Fever. | Cholera Infantum. | Dysentery. | Diarrhoea and Cholera Morbus. | Pneumonia. | Bronchitis. | Diseases of the Heart. | Diseases of the Brain and Spinal Cord. | Diseases of the Kidneys. | Cancer. | Suicide. | Accident. | Unknown or Ill-defined Causes. | All Other Causes. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newton, | 28 | - | 1 | - | 10 | 6 | 4 | 3 | 1 | - | 5 | - | 4 | - | 9 | 44 | 10 | 47 | 61 | 22 | 27 | 1 | 3 | - | 198 |
| North Adams, | 18 | - | - | - | 11 | - | 2 | 2 | 1 | 1 | 4 | - | 5 | 1 | 4 | 18 | 12 | 27 | 16 | 9 | 15 | 3 | 6 | - | 146 |
| Northampton, | 23 | - | - | - | 6 | - | 3 | - | 3 | - | 2 | - | 7 | 2 | 5 | 19 | 6 | 35 | 47 | 28 | 22 | 2 | 6 | 11 | 101 |
| North Attleboro, | 14 | - | - | - | 1 | - | - | 2 | - | - | 2 | - | 2 | 1 | - | 14 | 2 | 11 | 18 | 12 | 8 | 2 | 5 | 1 | 37 |
| Northbridge, | 8 | - | 2 | - | 1 | 4 | 2 | 3 | - | 3 | - | 2 | 6 | 2 | 1 | 15 | 6 | 8 | 2 | 2 | 6 | 1 | 5 | - | 31 |
| Norwood, | 7 | - | 1 | - | 2 | - | 2 | - | - | - | 1 | - | 4 | - | 6 | 5 | 1 | 17 | 5 | 1 | 3 | - | 5 | - | 24 |
| Orange, | 5 | - | - | - | - | - | - | 3 | - | - | 4 | - | 1 | - | 1 | 11 | 1 | 16 | 12 | 4 | 2 | 1 | 2 | - | 28 |
| Palmer, | 12 | - | - | - | - | - | - | - | - | 2 | - | - | 11 | 3 | 4 | 21 | 3 | 17 | 12 | 5 | 2 | 1 | 4 | 2 | 21 |
| Peabody, | 22 | - | - | - | 1 | - | 5 | 5 | - | - | 1 | - | 9 | 2 | 2 | 14 | 4 | 32 | 22 | 6 | 9 | 2 | 6 | - | 58 |
| Pittsfield, | 42 | - | - | 3 | 1 | 3 | 11 | 4 | 1 | - | 2 | - | 10 | 2 | 6 | 41 | 7 | 67 | 37 | 2 | 10 | 2 | 31 | 59 | 79 |
| Plymouth, | 18 | - | 1 | - | 1 | - | 2 | 9 | - | 1 | 1 | - | 12 | - | 2 | 7 | 8 | 34 | 13 | 12 | 4 | 2 | 6 | - | 66 |
| Quincy, | 44 | - | - | 3 | 13 | - | 3 | 6 | 1 | - | 1 | - | 7 | - | 22 | 40 | 6 | 64 | 30 | 12 | 15 | 3 | 19 | - | 78 |
| Reading, | 5 | - | - | - | 2 | - | 1 | 3 | - | - | - | - | 1 | - | - | 5 | 1 | 6 | 10 | 3 | 4 | - | 3 | - | 34 |
| Revere, | 26 | - | 1 | - | - | 2 | 4 | 6 | 2 | - | - | - | 7 | - | 1 | 26 | 4 | 17 | 13 | 19 | 7 | 1 | 14 | - | 36 |
| Rockland, | 4 | - | - | - | - | - | 7 | 3 | - | - | 1 | 1 | - | - | - | 6 | 2 | 13 | 8 | 12 | 7 | - | 3 | - | 35 |
| Salem, | 58 | - | 5 | - | 21 | - | 11 | 6 | 2 | - | 3 | - | 62 | 2 | 5 | 50 | 22 | 71 | 22 | 40 | 32 | 2 | 12 | - | 309 |
| Saugus, | 15 | - | - | - | 3 | - | 3 | - | - | - | - | - | 1 | - | 2 | 18 | 4 | 18 | - | - | 5 | 2 | 5 | - | 39 |
| Somerville, | 84 | - | - | 4 | 17 | - | 9 | 16 | 7 | - | 17 | - | 22 | 10 | 7 | 127 | 31 | 82 | 72 | 77 | 52 | 3 | 20 | - | 311 |
| Southbridge, | 20 | - | - | - | 23 | - | 4 | 1 | - | - | - | - | 14 | 4 | 13 | 5 | 10 | 7 | 25 | 11 | 3 | - | 2 | 28 | 22 |
| South Hadley, | 3 | - | - | - | 1 | - | - | 2 | - | - | 2 | - | - | - | - | 4 | - | 10 | - | 7 | 2 | 1 | 1 | - | 20 |
| Spencer, | 12 | - | - | - | 2 | - | 1 | 3 | - | - | - | - | 4 | - | - | 18 | 4 | 17 | 18 | 2 | 6 | - | 1 | - | 27 |
| Springfield, | 92 | - | 4 | 1 | 27 | 3 | 19 | 4 | 3 | 10 | 6 | 1 | 26 | - | 32 | 121 | 21 | 109 | 30 | 120 | 74 | 5 | 54 | 14 | 344 |
| Stoneham, | 18 | - | 1 | - | - | - | - | 2 | - | - | - | - | 1 | 4 | 4 | 11 | 2 | 16 | 13 | 8 | 10 | 2 | 2 | - | 16 |
| Stoughton, | 12 | - | 1 | 1 | - | - | - | - | - | - | 4 | - | 1 | 3 | - | 4 | 4 | 13 | 1 | 4 | 7 | - | 7 | - | 62 |
| Swampscott, | 9 | - | - | - | 1 | - | 5 | - | 1 | - | - | - | - | - | - | 4 | 2 | 19 | 2 | 8 | 1 | 2 | 4 | - | 16 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taunton, | 79 | - | - | 3 | 9 | 2 | 4 | 3 | 1 | 2 | 8 | 2 | 28 | - | 41 | 74 | 17 | 34 | 27 | 26 | 14 | 1 | 7 | 1 | 298 |
| Wakefield, | 22 | - | - | - | 1 | - | 1 | 4 | 1 | - | 2 | - | 1 | 1 | 2 | 18 | 2 | 22 | 22 | 3 | 10 | 1 | 8 | - | 38 |
| Waltham, | 28 | - | - | 1 | 4 | - | 12 | 5 | - | - | 17 | - | 4 | 1 | - | 40 | 10 | 40 | 53 | 20 | 14 | 4 | 10 | - | 97 |
| Ware, | 9 | - | - | - | 2 | - | - | - | - | - | - | - | 10 | - | - | 11 | - | 13 | 7 | - | 2 | - | 5 | - | 68 |
| Watertown, | 11 | - | 1 | - | 6 | - | - | 5 | 1 | - | 4 | - | 2 | - | - | 17 | 2 | 22 | 14 | 8 | 8 | - | 2 | 18 | 25 |
| Webster, | 18 | - | 3 | - | 6 | 3 | 2 | 5 | 1 | - | 3 | - | 7 | - | 8 | 14 | 6 | 12 | 10 | 2 | 8 | - | 5 | - | 46 |
| Wellesley, | 3 | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | 6 | - | 9 | 15 | 2 | 2 | - | 3 | - | 11 |
| Westborough, | 24 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 18 | 2 | 12 | 104 | 9 | 5 | 3 | 5 | - | 13 |
| Westfield, | 25 | - | - | 2 | 2 | - | 5 | 1 | - | - | 1 | - | 2 | - | - | 20 | 3 | 29 | 9 | 9 | 10 | 1 | 8 | - | 76 |
| West Springfield, | 14 | - | - | - | - | - | - | 2 | - | - | - | - | 9 | - | - | 10 | 1 | 14 | 3 | 8 | 3 | - | 9 | - | 37 |
| Weymouth, | 18 | - | - | - | 1 | 1 | - | 3 | - | - | 1 | - | - | 1 | - | 14 | 8 | 29 | 31 | 13 | 7 | - | 6 | 11 | 40 |
| Whitman, | 9 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 5 | - | 10 | 15 | 4 | 4 | - | 4 | - | 22 |
| Williamstown, | 5 | - | 1 | - | 1 | - | 1 | - | - | - | 1 | - | - | - | 1 | 8 | 4 | 4 | 5 | 3 | 6 | 2 | 1 | - | 16 |
| Winchendon, | 2 | - | - | - | - | 5 | - | - | - | 1 | - | - | - | - | 2 | 6 | 1 | 7 | 10 | 5 | 5 | - | 4 | - | 32 |
| Winchester, | 6 | - | - | - | - | - | - | 1 | - | 1 | - | - | 2 | - | 1 | 10 | 4 | 12 | 16 | 5 | 7 | - | - | 3 | 24 |
| Winthrop, | 3 | - | - | - | - | - | - | 1 | - | - | - | - | 2 | 2 | - | 16 | - | 12 | 18 | 7 | 6 | - | 5 | - | 28 |
| Woburn, | 25 | - | - | - | 2 | - | 3 | 1 | - | - | - | - | 1 | 1 | - | 30 | 12 | 36 | 13 | 14 | 13 | 1 | 8 | - | 63 |
| Worcester, | 228 | - | 6 | 4 | 12 | 18 | 26 | 14 | 10 | 6 | 3 | 3 | 119 | 6 | 18 | 242 | 36 | 270 | 334 | 117 | 96 | 26 | 60 | - | 572 |
| | 4,144 | 2 | 157 | 111 | 570 | 164 | 484 | 612 | 135 | 87 | 315 | 34 | 1,522 | 161 | 1,074 | 4,596 | 1,115 | 4,494 | 3,815 | 2,333 | 2,064 | 283 | 1,522 | 519 | 13,068 |

| | Homicide. |
|---|---|
| Beverly, | 1 |
| Boston, | 14 |
| Brockton, | 1 |
| Cambridge, | 1 |
| Hyde Park, | 1 |
| Lawrence, | 2 |
| Lowell, | 1 |
| Pittsfield, | 1 |
| Quincy, | 1 |
| Waltham, | 1 |
| Worcester, | 1 |
| | 25 |

| | Tetanus. |
|---|---|
| Hyde Park, | 1 |

| | Hydrophobia. |
|---|---|
| Lowell, | 2 |

| | Anthrax. |
|---|---|
| Lynn, | 1 |

## Table IV.

*Deaths from Specified Causes, 1905, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1901-1905), Deaths per 1,000 from All Causes, 1901-1905.*

| Causes of Death. | Deaths 1905. | Mortality per 10,000 of the Population. | | | | | Deaths per 1,000 from All Causes. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1905. | 1904. | 1903. | 1902. | 1901. | 1905. | 1904. | 1903. | 1902. | 1901. |
| Consumption, | 4,144 | 16.01 | 16.05 | 15.66 | 16.38 | 17.63 | 95.46 | 103.76 | 97.06 | 101.06 | 104.58 |
| Smallpox, | 2 | 0.008 | 0.03 | 0.08 | 1.12 | 0.39 | 0.046 | 0.20 | 0.51 | 6.89 | 2.30 |
| Measles, | 157 | 0.61 | 0.63 | 0.69 | 0.92 | 0.73 | 3.62 | 4.04 | 4.27 | 5.66 | 4.35 |
| Scarlet fever, | 111 | 0.43 | 0.43 | 1.75 | 1.13 | 1.46 | 2.56 | 2.77 | 10.85 | 6.99 | 8.64 |
| Diphtheria, | 570 | 2.20 | 2.38 | 2.94 | 3.22 | 4.40 | 13.13 | 15.39 | 18.20 | 19.84 | 26.13 |
| Whooping cough, | 164 | 0.64 | 0.45 | 1.64 | 0.96 | 0.84 | 3.78 | 2.92 | 10.19 | 5.96 | 4.99 |
| Typhoid fever, | 484 | 1.87 | 1.59 | 1.81 | 1.88 | 1.96 | 11.15 | 10.29 | 11.24 | 11.59 | 11.61 |
| Cerebro spinal meningitis. | 612 | 2.36 | 1.13 | 1.33 | 1.39 | 1.46 | 14.10 | 7.28 | 8.23 | 8.60 | 8.69 |
| Erysipelas, | 135 | 0.52 | 0.58 | 0.35 | 0.44 | 0.47 | 3.11 | 3.77 | 2.16 | 2.74 | 2.79 |
| Puerperal fever, | 87 | 0.34 | 0.27 | 0.33 | 0.32 | 0.34 | 2.00 | 1.72 | 2.04 | 1.98 | 2.00 |
| Influenza, | 315 | 1.22 | 0.77 | 1.06 | 0.43 | 1.90 | 7.26 | 4.97 | 6.60 | 2.64 | 11.29 |
| Malarial fever, | 34 | 0.13 | 0.11 | 0.16 | 0.15 | 0.19 | 0.78 | 0.74 | 1.02 | 0.94 | 1.14 |
| Cholera infantum, | 1,522 | 5.88 | 5.21 | 5.89 | 6.05 | 6.11 | 35.05 | 33.67 | 36.50 | 37.36 | 36.28 |
| Dysentery, | 161 | 0.62 | 0.63 | 0.62 | 0.70 | 0.72 | 3.71 | 4.07 | 3.88 | 4.35 | 4.25 |
| Diarrhœa and cholera morbus. | 1,074 | 4.15 | 3.59 | 3.29 | 3.71 | 3.54 | 24.74 | 23.21 | 20.36 | 22.88 | 20.99 |
| Pneumonia, | 4,596 | 17.75 | 15.85 | 16.48 | 16.07 | 16.66 | 105.85 | 102.46 | 102.11 | 99.21 | 98.83 |
| Bronchitis, | 1,115 | 4.31 | 4.23 | 4.55 | 4.69 | 4.47 | 25.69 | 27.37 | 28.17 | 28.96 | 26.50 |
| Diseases of the heart, | 4,494 | 17.36 | 16.21 | 15.25 | 15.66 | 15.70 | 103.50 | 104.79 | 94.52 | 96.40 | 93.12 |
| Diseases of the brain and spinal cord. | 3,815 | 14.74 | 12.56 | 11.15 | 12.17 | 10.41 | 87.88 | 81.24 | 69.10 | 75.12 | 61.76 |
| Diseases of the kidneys, | 2,333 | 9.01 | 8.24 | 8.45 | 7.38 | 7.75 | 53.75 | 53.30 | 52.36 | 45.57 | 46.01 |
| Cancer, | 2,064 | 7.97 | 7.34 | 7.05 | 6.91 | 6.19 | 47.55 | 47.49 | 43.70 | 42.66 | 36.75 |
| Suicide, | 283 | 1.09 | 1.03 | 1.05 | 1.02 | 1.05 | 6.52 | 6.69 | 6.50 | 6.30 | 6.22 |
| Accident, | 1,522 | 5.88 | 5.14 | 5.43 | 5.40 | 5.39 | 35.06 | 33.25 | 33.66 | 33.31 | 31.95 |
| Unknown or ill-defined causes. | 519 | 2.00 | 1.70 | 1.91 | 1.64 | 1.77 | 11.96 | 10.98 | 11.84 | 10.11 | 10.52 |
| All causes, | 43,410 | 167.67 | 154.65 | 161.32 | 162.07 | 168.58 | - | - | - | - | - |

# HEALTH OF TOWNS.

# HEALTH OF TOWNS.

The following digest consists chiefly of extracts from the annual reports of the boards of health of cities and towns for the year 1905, illustrating the character and extent of the sanitary work performed by the local authorities.

Forty-four cases of smallpox were reported for the year 1905, as against 100 for the year 1904 and 417 for the year 1903, showing a marked decrease in the prevalence of this disease.

There was a slight increase in the number of reported cases of scarlet fever for the year 1905, as compared with the number reported for 1904. The largest number of deaths from this disease occurred in Lawrence (10 deaths in 95 cases), the fatality being 10.5 per cent. In Boston there were 1,131 reported cases and 44 deaths, a fatality of 3.9 per cent.; in Cambridge, 146 cases with 4 deaths, the fatality being 2.7 per cent.; in Fall River, 67 cases with 3 deaths, the fatality being 4.5 per cent.; in Somerville the fatality was 3 per cent.; in Worcester, 5.3 per cent. In Lowell and Newton there were 48 and 78 cases, respectively, with no deaths.

The following numerical statement of bacteriological work performed by local boards of health is also taken from the annual reports of those boards for the year 1905: —

*Bacteriological Work performed by Local Boards of Health and by the State Board of Health, 1905.*

| | Diphtheria Cultures. | Tuberculosis. | Typhoid Fever. | Malaria. |
|---|---|---|---|---|
| Boston,[1] | 7,331 | 3,650 | 1,281 | 182 |
| Brockton,[2] | 101 | 274 | 176 | 110 |
| Brookline, | 782 | 148 | 72 | 27 |
| Cambridge, | 1,423 | 309 | 248 | - |
| Fall River, | 289 | - | 108 | - |
| Fitchburg, | 137 | 107 | 54 | - |
| Greenfield, | 20 | - | - | - |
| Holyoke, | 520 | - | - | - |
| Lowell, | 1,096 | 426 | 155 | 1 |
| Lynn, | 272 | - | - | - |
| New Bedford, | 425 | 110 | - | - |
| Newton, | 186 | 26 | 43 | - |
| Palmer, | 11 | - | - | - |
| Somerville, | 792 | 162 | 78 | - |
| Springfield, | 1,406 | 147 | - | - |
| Waltham, | 298 | 59 | 74 | - |
| Worcester, | 1,346 | 420 | - | - |
| State Board of Health, | 3,382 | 1,090 | 459 | 21 |

[1] Glanders, 194; other diseases, 155.

[2] Other diseases, 52.

### Beverly.

Quite a number of cases of typhoid fever were reported during September and the early part of October. Many of these cases were on the line of a certain milk route, and the board, after a most careful investigation, were of the opinion that the source of infection could be traced to this milk supply; the dealer was at once notified to discontinue the delivery of his milk, and good results were at once apparent, which seemed to confirm the opinion of the Board.

The care, storage and handling of milk is a matter of great importance, and this board cannot too strongly urge upon all the necessity for keeping everything thoroughly clean where milk is placed. This includes care of cattle, drainage and cleanliness of stables, cooling and rehandling the article.

### Boston.

The total number of deaths for the year was 11,007, an increase over the previous year of 250 deaths. The census population, in the middle of the year, was 595,380. The death-rate for the year, as calculated on this population, is 18.49 per 1,000 inhabitants. This rate was greater by 0.21 than that of the previous year, but lower by 1.78 than the average of the previous ten years. There were 2,161 deaths from infective diseases, including consumption, a decrease of 150 deaths. There were 74 fewer deaths from diphtheria and croup than in 1904, and a proportionate decrease in the number of cases. The percentage of deaths to the number of cases of diphtheria reported was 8.52, as against 8.12 per cent. the preceding year. There were 44 deaths from scarlatina, 5 more deaths than in the preceding year, and 62 deaths less than the average for the ten previous years. Typhoid fever caused 117 deaths during the year, 18 less deaths than the preceding year. Fifty-eight of the deaths from this cause occurred during the months of August, September and October, and 66 of the whole number died between the ages of twenty and forty years.

There were 54 deaths from measles during the year. The number of deaths of children under five years of age was 3,024, compared with 3,105 for the previous year, showing a decrease of 81 deaths. The respiratory diseases caused fully 25 per cent. of the mortality for the past year.

*Smoke Nuisance.* — The smoke nuisance in Boston having grown to such proportions in the last few years as to become a source of general discomfort and complaint, the subject was taken in hand by a few public-spirited citizens, who asked for relief by the Legislature of 1902. Being defeated in 1902, and again in 1903, a third appeal was made in

1905. At this time an act was passed which differs somewhat from the old smoke law, and places its enforcement upon the board of health.

In December, 1905, shortly before the law went into effect, the board distributed copies of the new law among those who were likely to make an excessive amount of smoke, and prefaced each by notice that the board of health would commence the enforcement of the new law on Jan. 1, 1906. The department had seventeen sanitary inspectors in as many sanitary districts, into which the city is divided. Their daily inspections and observations in these districts were such as to render them easily available for the new duties, without material hindrance to their general work. The board knew them to be thoroughly competent and found them willing and ready to take on the new duties, under the instructions of the board and the immediate supervision of the chief sanitary inspector. These inspectors are instructed to make note of the exact time and extent of any violation of the smoke law, to carefully identify the chimney from which the smoke issues, without entering buildings, when it can be avoided, and to neglect all talk about particular "smoke-consuming" devices and fuel.

During the month of January, the inspectors reported violations of the law in 174 different places. Notices in all cases were sent by the board and responses made by representatives of the several hotels, stores, factories, office buildings, schools, colleges and various industries. Conferences between the board of health and the business men who have responded to these notices have resulted most satisfactorily, with a full understanding of the import of the law, the prospect of its being enforced, and a mutual desire to see the smoke nuisance abated. A very general request is being made, under the permit clause of the law, for time in which to make constructive alterations or other changes by which the amount of smoke can be reduced, to comply with the law. In many instances no material alterations will be necessary to keep within the requirements, except that of securing proper and faithful stoking. In no instance has the board of health recommended any special device or kind of coal as a remedy. It has, however, emphasized the importance of sufficient boiler capacity and intelligent stoking as the primal means not only for reducing the amount of smoke to the legal limit, but for reducing the fuel expense and the demand for special additional apparatus.

It was found necessary to prosecute but one case, and that was placed on file on the plea of guilty, and assurances that the infraction would not be repeated.

There was a marked decrease in the amount of smoke during the month of January except from sources which are exempt by law, and it

is confidently expected that a progressive decrease in the amount of smoke to the lawful limit will be seen from now on, and probably without many prosecutions.

*Medical Inspection of Schools.* — It is now nearly twelve years since this work was begun in Boston. For some years the board of health has asked permission to increase the amount of inspection in our schools, to improve the present incomplete surveillance over the pupils and others while suffering from infectious diseases at home, to guard the return to school of pupils convalescing from infectious or unreported diseases, to point out more of the existing physical and mental defects among the school children, by which they are more or less incapacitated for their work, and for which relief might be found, and thus render greater service to the schools and the public. This additional service can be secured for a moderate increase of expense, which can be met within the present appropriation.

*Removal of Buildings.* — The removal of buildings and parts of buildings on account of evils in themselves or because they make other buildings unfit for habitation, and which cannot be remedied by repairs, has continued to receive an increasing amount of attention, with gratifying results, not only from a sanitary point of view, but from the fact of a diminishing opposition. This work is invariably followed by increased sunlight and therefore a drier and cleaner air for the yards, kitchens, basements, halls, closets and stairways of the remaining buildings. There is an immediate and corresponding improvement of premises, cheerfulness of tenants and a gradual approval of landlords. One hundred and sixty-nine buildings were removed.

*Bacteriological Laboratory.* — The total number of routine bacteriological examinations made between Feb. 1, 1905, and Feb. 1, 1906, was 18,321. Of these, 12,762 were diagnosis and 5,559 were milk examinations.

Special examinations during the past year have included examinations for the organisms causing anthrax, leprosy, rabies, cerebro-spinal meningitis, septic wounds, etc., and for diphtheria and streptococcus virulence.

The board offers to make examinations, free of charge, of any disease of a bacteriological nature.

*Bacteriological Examination of Milk.* — During the year a new method of estimating the number of bacteria in milk by direct microscopical examination has been devised by the first assistant of the laboratory.

*Examination of Sputum.* — As each year has seen a decided increase in the number of sputum specimens to be examined, methods have been devised which have either materially shortened the time consumed in preparing the specimens or have increased the efficiency of the examina-

tion. Recently (December, 1905) a shaking machine was devised by the present director of the laboratory in which sixteen sputum bottles can be placed at one time and shaken until all caseous particles and coagulated lumps are broken up and the contents of the bottle rendered homogeneous throughout. The chances of finding the bacilli of tuberculosis when these are very few in number are undoubtedly increased by this method.

*Special Investigations.* — Acting in accordance with instructions from the board, the following inspections, investigations and analyses were made during the year: —

Keeping of lobster "floats" in polluted water.
Wall papers as infecting agents.
Drawn *versus* undrawn fowl.
Miscellaneous tests.

Included in the work of the board for the past year are two series of tables, one series showing the comparison of deaths in a few large American and foreign cities, as compared with the city of Boston, the other showing the annual increase in the number of cremations in the principal cities of this country and of Europe for the period 1876–1905, inclusive.

The board has also adopted regulations relative to the handling and storing of manure, thus doing away with the old-fashioned manure pit.

## Brockton.

For several years this board has repeatedly called attention to the matter of medical school inspection. With the experience of other cities which have adopted inspection, and which show a great reduction in the number of contagious cases, with a consequent decrease in the death-rate, it seems criminal to further neglect so important a matter. The board again adds its appeal and trusts some action will be taken in the matter this year.

During the year successful efforts were made in procuring, for the use of the board, a building where comfortable and humane provisions may be afforded those sick with contagious diseases who have not a home of their own. The house has been opened three times since its completion (November 1), and the board is of the opinion that a clean, sanitary building, with good air and the best of care, has had much to do with the speedy recovery of the patients taken there.

Brockton should have, as soon as possible, a hospital for communicable diseases, where every case of scarlet fever and diphtheria might be sent, if necessary.

A new feature adopted by the laboratory the past year, and now available for the physicians of the city, is the examination of blood for aid in diagnosis of other diseases besides malaria and typhoid fever.

## Brookline.

The board is trying the experiment of inducing two or three men with consumption to live in one of the smaller hospital buildings, temporarily unused for other purposes, where they can live a life largely out of doors, and where they can see their families and friends without danger.

The noticeable decrease in mosquitoes during the spring and summer may be attributed in part to the weather conditions, but it is undoubtedly due to a large extent to the effective work done under the direction of the assistant bacteriologist. Landowners have helped a little more than in previous years, and a good many troublesome holes have been filled up, so that water will no longer stand in them to form breeding-places for mosquitoes. Additional areas have been controlled by petrolizing, notably between Commonwealth Avenue and Beacon Street, where the rise and fall of the tide in Charles River is felt, and where a type of mosquitoes common in brackish water, but unknown elsewhere in Brookline, is found. The gross expenditure for mosquito work was $626.30, but landowners for whom work was done repaid $130.43, and there are charges to other landowners still unpaid which amount to $60.15. It is proposed to continue this work this year at an estimated cost of $750, the additional cost being chiefly for supplies and repairs of wagon and harness.

Most of the work done in connection with malarial fever was of a permanent nature, namely, the draining or filling in of stagnant pools found to be breeding malarial mosquitoes. Over a thousand street catch-basins, located in thickly settled parts of the town and found to be breeding-places of the common mosquito, were treated with petroleum by the street department about every four weeks throughout the season. It is very necessary that landowners should coöperate more generally with the board in its efforts to abate the prevalence of malarial and of common mosquitoes in the town, especially in the more thickly settled parts, if the best results are to be obtained.

The systematic medical inspection, at least once a week, of the pupils of the public schools and of the parochial school, more fully referred to in last year's report, was continued throughout the school year. The agent of the board of health, accompanied by the medical inspector of each school, visited every school at least once during the past year, and found teachers and physicians earnestly coöperating to safeguard the health of the pupils while in the somewhat crowded condition inseparably

connected with instruction in large classes in-doors. Hygienic drinking fountains have now been put into most of the buildings, and also on three playgrounds close to public schools, thus removing the chance of contracting disease from infected drinking cups. In September, copies of a circular, calling attention to the need of teaching personal cleanliness and to certain other measures that tend to prevent the spread of communicable disease among school children, were issued to all the regular teachers.

Arrangements are now made for an examination, by specialists, of the eyes, ears, noses, throats and teeth of the pupils in our largest and most representative school, the Pierce school, where a little over 800 children are enrolled. Since the neglect of physical defects in children results in many cases in partial arrest of physical and mental development by reason of eye strain, deafness, nervous troubles, premature decay of the teeth, and other forms of serious but preventable impairment of health, the importance of this new measure is very great. If successful in the Pierce school the pupils of the other schools will be similarly examined in a careful, judicious manner, and whenever necessary a note will be sent to the parent suggesting the taking of the child to the family physician for advice as to further examination by a specialist.

As a means of maintaining and further improving the health of the people, not only the various special measures mentioned in this report must be continued, and, where practicable, improved upon, but a number of additional measures deserve and are receiving consideration. Among these should be mentioned the providing of as many places as practicable for exercise and recreation in our public parks and playgrounds, and in the commodious, centrally located and well-equipped municipal gymnasium that has been planned and is soon to be erected. The experience with the playgrounds we already have indicates that they are fully appreciated, and of very great service to the health of the children and the youth of the town.

The experience also at the public baths on Tappan Street, where over 57,000 baths were taken the past year, and also at the Lincoln and Heath schools, where excellent shower baths have been installed and are used more and more by the school children, indicates that facilities provided by the town are appreciated and availed of by the citizens.

The investigation of the source of milk supply and methods of handling, sterilizing of jars, etc., immediately after a case of contagious disease is reported, is a new departure, and although this work was begun only last October, it has already disclosed many cases of carelessness, and brought about so many improvements, that it is evident its continuance will lessen the spread of contagion through milk, and will enable

the inspector to have a detailed record of everything connected with any questionable milk supply. Thus, if any considerable number of cases appear upon one dealer's route, the conditions can be readily and quickly corrected.

It was found in connection with this that drivers were taking milk from houses where cases of contagious disease existed, contrary to the regulations of the board of health, being unaware of the fact, as a small card on the front door does not serve as a warning to the many drivers and others who invariably use the rear entrance. Although a driver of a milk wagon is promptly notified of a case upon his route as soon as it is reported to the department, it would seem advisable to have the rear doors of quarantined houses placarded as well as the front.

The work of dairy inspection has been more extensively done than in the past, and with very gratifying results. Over 100 places were inspected, the larger part being dairies which had not been previously visited. It was found that the best results could be obtained by having the licensed dealer accompany the inspector to the dairies from which his own supply came. Unsanitary conditions could then be more forcibly explained to both dairyman and dealer, and instructions given as to their correction, under penalty, in some cases, of having the milk from unsanitary dairies excluded from sale in the town of Brookline. The better class of milk dealers are learning that milk properly produced, cooled and handled will not only retain its sweetness longer and yield larger returns, but that it is a valuable asset to their business to have it known that their supply comes from dairies which are recorded as clean and sanitary, and under the supervision of, and regularly inspected by, this department. It has been found necessary to shut out but a few undesirable producers. In most cases where the dairyman has not been properly cooling or storing his milk, the suggestions offered resulted to his pecuniary advantage. As an example, one Sudbury dealer who had been cooling his milk in a stagnant pool behind his barn, as he had no available proper water supply, was having an average of twelve cans a month returned to him as unsalable. He was notified through the dealer that he must provide an artificial cooler, which was installed in April. When a second visit was made in August, it was found that not a can had been returned to him since the cooler was installed.

The records of over 200 dairies, showing their sanitary conditions, methods of production, handling, etc., are now on file at the milk inspector's office at the town hall. Judging by the number of citizens who have looked over these records during the year, and the fact that the most reliable dealers are reporting an increase in their output, while others report a decrease, this work is bearing fruit in the right direction.

## CAMBRIDGE.

The diseases discovered in the schools, through medical inspection, and the number of cases are as follows: —

| | |
|---|---|
| Chicken pox, | 7 |
| Measles, | 9 |
| Mumps, | 18 |
| Scarlet fever, | 1 |
| Whooping cough, | 10 |
| Pediculosis, | 105 |
| Diseases of ear, | 9 |
| Diseases of eye, | 75 |
| Diseases of skin, | 137 |
| Diseases of nervous system, | 5 |
| All other diseases, | 174 |
| Total, | 550 |

The board recommends that the city build a modern hospital for the care and treatment of infectious diseases, such as diphtheria, scarlet fever, measles and typhoid fever. There should also be a hospital for the care and treatment of persons suffering with tuberculosis of the lungs. The buildings, formerly dwellings, which were used during the smallpox epidemic, should be destroyed, as they are unfit for habitation, and an inexpensive wooden structure should be built for smallpox cases, to be destroyed after a smallpox epidemic, and a new building of a similar type constructed.

Several years ago the board passed a regulation for proper ventilation of cars, but it was powerless to direct any specific method of ventilation. This year steps were taken to have the railroad commissioners given authority to investigate the manner of ventilating street cars, with power to adopt any method they deemed expedient. A bill to this effect was presented to the Legislature, but it was contended that the railroad commissioners could secure better ventilation without the passage of this bill. The bill failed of passage. The board again proposes to renew its efforts in that direction, because it feels that thereby the spread of infection would be prevented, and the vitality of passengers would not be weakened by riding in improperly ventilated cars.

The following recommendations have been made by the board: that there should be an incinerator, located in some isolated section of the city, where rubbish could be burned; that, in view of the nuisance existing at Cider Mill Pond, caused by the emptying into it of the refuse from several basins at the Payson Park reservoir, the pipe running from the reservoir to the pond be connected with the sewer; that the city make

some arrangement with the owner of the clay pit on Sherman Street in North Cambridge to have the same filled in; that the sewer in North Cambridge which enters Tannery Brook, the sewage from which flows along and enters Alewife Brook, is a menace to the health of the neighborhood, and should be remedied without delay; that the building ordinances be amended so as to provide that all water-closets be ventilated by a vent.

The board has directed the sanitary inspectors to make a report upon the sanitary condition of all stables in the city, in accordance with its requirements.

In March new sputum outfits were sent out, consisting of a square pasteboard box, containing a labelled bottle, with wide mouth, in which are a few drachms of 5 per cent. carbolic acid. A smaller and more serviceable test-tube has been adopted for the diphtheria outfits, and the boxes for these outfits were recently changed from those open at both ends to a form which is closed on three sides, obviating the danger of dropping the box and tubes while holding the cover.

### Chicopee.

At the February meeting, the board made arrangements with Springfield for supplying physicians of Chicopee with swabs, whereby they might avail themselves of a bacteriological diagnosis in cases of sore throat of doubtful character. It is not the intention of the board at this time to require swabs to be taken in every case of diphtheria which may come to the notice of physicians, but the opportunity is now offered for the examination of swabs taken from any suspected case. It is only by a bacteriological examination of such cases that the true diagnosis can be made.

### Fall River.

The death-rate has never before been so low as it was for the year just closed, with the exception of last year, when the number of deaths was somewhat lower. Contagious and other preventable diseases reported were also low, as compared with other years.

Although the outbreak of cerebro-spinal meningitis caused grave apprehension while it lasted, the stringent measures adopted for its eradication proved effective, and the epidemic was of short duration. Cerebro-spinal meningitis and erysipelas have been added to the list of contagious diseases.

Last year a regulation was adopted, which went into effect July 1, making consumption a notifiable disease. This regulation was published in all of the daily newspapers of the city and was afterwards printed in pamphlet form, together with directions for the care of consumptives and

those living with them. This pamphlet, with a circular letter, announcing the action of the board, and a supply of stamped envelopes and printed forms upon which to report cases, were delivered to every physician in the city, whose coöperation was asked in combating the disease. Since the regulation went into effect, the residence of every person who has died of consumption, or of those who have been reported ill and may have moved out of the tenement, has been fumigated by the department, and such repairs and renovations as have been considered necessary have been required of the owner before he is given a permit to reoccupy the premises. Besides what has been accomplished through this regulation, over 500 spitting notices were posted in the principal streets and public places of the city, and others will be put up this spring.

Since the enactment of the law making it obligatory for boards of health to care for cases of contagious and infectious diseases, and maintain one or more hospitals for that purpose, an old house has been made to do service as a contagious hospital. Many repairs and improvements have had to be made upon this building since, but even with these it is only a makeshift of a contagious hospital, and it is only with considerable trouble and risk that more than one kind of disease can be accommodated there at the same time. A building with better facilities should be provided.

The necessity for an inspector of meats and provisions is very great, particularly as almost every city of any size and many towns in this and adjoining States have an inspector of meat, and the absence of such an officer here makes this city a desirable market place for dealers in a class of goods that would not be allowed in other cities.

The medical inspection of schools, at least at the reopening after each vacation, is of vital importance, and the board recommends an appropriation for the purpose. Up to the present time inspection has been done only as an emergency measure in a general way at the reopening of schools in September.

No cases of smallpox have been reported during the year. Since the smallpox epidemic and general vaccination in 1903 the vaccination laws have been rigidly enforced. Vaccination is provided free of expense at the office of the board of health, and school children are required to produce certificates of successful vaccination from the family physician or the board of health before being admitted to school. The teachers in all schools, public, parochial and private, scrupulously observe this rule. During the year, 2,063 persons were successfully vaccinated at the office of the board.

The records show again this year another substantial decrease in the number of cases of scarlet fever. This reduction has, undoubtedly, been

brought about by an inspection of the patient in every case by one of the district physicians before an order is given to fumigate the premises or release the quarantine, and the greater strictness with which the quarantine regulations were made and enforced in late years.

### Fitchburg.

No epidemic of any disease has appeared during the past year. It is interesting to observe that the number of cases and also the number of deaths from tuberculosis and pulmonary phthisis are 40 per cent. and 20 per cent., respectively, less than last year. The board recommends a careful consideration of the necessity of caring for persons afflicted with tuberculosis in its various forms. This should be done for the welfare of those ill with the disease and for those coming in contact with them.

During the year a large number of children have been vaccinated at the office of the board without expense to the city, this plan proving the most satisfactory way to obtain the desired and necessary vaccinations. In September, free vaccine virus was supplied the physicians of the city, furnished by the State, and it has been uniformly and highly satisfactory.

The milk farms have been inspected more generally than usual, and in several instances the defective sanitary conditions found upon the premises have been remedied. A constant and general supervision should be maintained of milk-producing plants at such intervals as to furnish the public at all times with pure, clean milk.

Early in the year it was voted by the board to include cerebro-spinal meningitis in its list of notifiable diseases.

In May, the full board inspected that portion of the city through which Punch Brook runs, lying between Mechanic Street and Rindge Street, finding it in a very filthy condition and dangerous to the public health. A communication was addressed to the city government, calling its attention to the conditions existing there, and recommending that said brook be properly enclosed in retaining walls and covered, in accordance with the provisions of chapter 188, Acts of 1869.

### Haverhill.

The city has been reasonably free from contagious diseases. Diphtheria has been more prevalent, 74 cases having been reported, with 8 deaths, as compared with 37 cases and two deaths in 1904.

In the absence of any medical supervision of the schools, it is impossible to prevent occasional epidemics of contagious diseases. With medical inspection at regular intervals, knowledge of the existence of these diseases would be obtained and their spread prevented. This has been frequently urged in the annual reports of the board and was recommended last year by the school board.

### Holyoke.

The board is pleased to state that the general public health and the sanitation of the city is in a satisfactory condition. This favorable state of affairs has been brought about gradually by constant attention during the past few years to all nuisances, sources of filth and causes of infection. There exists to-day a very general desire on the part of the people of the city to comply with the rules of the board and the State laws relating to the same. Many of the old and dilapidated buildings about the city have been removed, thus eliminating foci of contagion and filth.

The passage through the city of the sewage-laden canal water is a constant menace to the general health of the people, and it is hoped that the near future will see these canals relieved of this objectionable feature.

The completion of two additional sections of sewers has enabled the board to abate nuisances formerly existing, and the city is now practically free from vaults and cesspools.

A noteworthy fact to be mentioned in connection with the year's work is the very high percentage of positive cases which have been released only upon the finding of a negative culture. There has been a steady improvement in this line from year to year, and during 1905 practically all positive cases have been so treated.

### Hyde Park.

Early in the year 1905 the attention of the board was called to the infectiousness and prevalence of cerebro-spinal meningitis, or spotted fever. As a result, the board passed a regulation relative to cerebro-spinal meningitis and tuberculosis, adding them to the list of notifiable diseases.

### Leominster.

The board now has a well-equipped laboratory, furnished with the latest necessary utensils. That this is fully appreciated by the physician is shown by the large number of specimens brought for examination. The laity are beginning to recognize the value of such a laboratory by bringing in specimens themselves for examination.

The board has adopted rules which govern these examinations. These rules are similar to those in use in other large towns and cities having laboratories.

The board would urge upon all families in which a death occurs from tuberculosis to immediately notify the board of health, in order that their houses may be properly fumigated and other proper precautions taken, as in other contagious diseases.

In order to eliminate as much as possible the spread of the so-called milder contagious diseases in the schools, it has been deemed best by

those connected with the schools and by the board to hereafter require a school certificate from the board of health readmitting those who have been kept out of schoool in cases of measles, mumps and whooping cough.

### Lowell.

The death-rate of Lowell for the year 1905 was the third lowest in the past sixteen years. Aside from the epidemic of cerebro-spinal meningitis, the mortality from contagious diseases shows a favorable record. The board has now adopted a rule placing cerebro-spinal meningitis in the same category with diphtheria as regards the placarding of houses and funeral restrictions.

In December, 1904, the city council voted to borrow $10,000, to be expended for a cremator, under the direction of the board of health. Accordingly, the various incinerators which, in the opinion of the board, would most likely meet the requirements of the city, were investigated, and an incinerator has now been installed and is in operation in Ayer's City.

### Lynn.

The death-rate at the contagious hospital during the past year has been very low. Out of 107 admitted, but 4 died. Of those admitted, there were 30 cases of diphtheria, 62 of scarlet fever and 12 of erysipelas. There were also 3 patients cared for, each of whom had diphtheria and scarlet fever combined. Of the latter, all recovered.

Many inspections of the markets and stores where perishable provisions are sold have been made in order to restrict the sale of decayed or unwholesome fruits or provisions. Special attention has been paid to the fruit stores and also to the teams of all hawkers or peddlers, who are required by ordinance to have a license or permit before making any sales, and a decided improvement has been made in this direction. Five hundred and fifty-nine inspections have been made of fruit and provision stores and 274 of the teams of hawkers and peddlers. One hundred and ninety permits have been granted during the year.

### Malden.

During the past year the city has been very free from contagious diseases, there having been only 42 cases of measles, 89 of diphtheria, 47 of scarlet fever and 52 of typhoid fever, making a total of 230 cases, with only 7 deaths.

The board still continues the medical inspection of the public schools (employing four physicians for that work) and they feel satisfied that the results show well for the small amount expended.

The board believes that the time has arrived when it should require that all cases of tuberculosis should be reported and that all care be taken to prevent the spread of the disease.

### MELROSE.

The board has made a change in its regulations by adding cerebro-spinal meningitis to the list of diseases to be reported.

During the year, the board has circulated through the schools 3,000 copies of a circular obtained from the Boston Association for the Relief of Tuberculosis, with an addendum by the local board, giving in brief what is desired in cases of consumption.

Relative to the act requiring all cases of sore eyes in an infant under two weeks of age to be reported to the board of health, a notice was published and sent to physicians and nurses, informing them that the board was prepared to make the necessary cultures as required for the determination of these cases.

The isolation hospital was open 246 days during the year 1905, caring for 16 patients. There were no fatalities. It is the judgment of the board that the isolation hospital was of immense value in the care of contagious diseases during the year. It may be looked upon as a sort of insurance for the rest of the community, which is to be measured largely for its general protection and not wholly by the comparatively few cases that it cares for. It has been the policy of the board to care for all cases when in the opinion of the attending physician the case could not be properly isolated at home. It has also been the policy of the board to take care of as many cases as possible at the hospital when the mother of the family was the sole nurse. Another class of cases that should be cared for at the hospital are those where more than one family occupy a house, and the family or families not having cases are subject to the annoyance and expense of quarantine.

With the beginning of the school year in September, the board of health began a regular medical inspection of the schools of the city.

Fifteen successful vaccinations were performed at the office and 120 certificates of vaccination issued. The board continues to receive vaccine virus from the State Board of Health. It is received fresh as required, and its use gives much satisfaction, not only in the successful results of vaccination but in the absence of all untoward effects.

During the month of February the board had printed upon cards 14 by 16 inches a notice relative to spitting in public places. Janitors, when questioned, have unanimously testified to the good effect of this notice.

The report of the inspector of milk and vinegar shows that only a few

of the samples of milk taken have been found to be below the standard required by law, and these only slightly. One dairy that was supplying a local dealer was dropped for selling milk below the standard and this milk does not come to the city now. Most of the milkmen are desirous of having the best milk to be had, and the people of the city are fortunate in having a large number of good dairies near which supply a large part of the milk.

### New Bedford.

With the exception of January and the last two months of the year, the city has been particularly free from contagion. During the three months mentioned, diphtheria prevailed to some extent, but otherwise there were but few cases of contagious disease. During a portion of the summer not a single house was quarantined for a disease dangerous to the public health, which is a feature in the sanitary work of the board seldom realized.

There never has been a time in the history of the city when the collection of garbage has been so thoroughly performed as during the year 1905. The disposal of garbage by the Wheelwright process has proven a signal success. The material has been quickly destroyed, and in such a manner that no one could justly find fault. Experts from various cities who have examined the plant have spoken in the highest terms of praise of its success, while the absence of unpleasant odors during the process of destruction makes the plant an ideal one from a sanitary standpoint.

With but very few exceptions, the tenement blocks in this city (except where no sewer abuts the premises) have been plumbed in a sanitary manner. During the year the board made another inroad upon the congested section by ordering the removal of outbuildings, and in the twelve months which have elapsed no less than 54 houses were ordered plumbed and the vaults on the premises abandoned.

### Newton.

In the early months of the year there was a number of cases of epidemic cerebro-spinal meningitis, and some alarm was felt in regard to it. The number of cases reported, however, was only slightly in excess of the average. To prevent alarm on the part of the citizens, the board instructed the undertakers to treat the bodies of persons dying from this disease in a manner similar to those of persons who died of other contagious disease, and the rooms where such patients had been ill were disinfected. No quarantine was imposed, nor were the patients isolated.

A meeting between the board and a sub-committee of the school committee was held during the autumn to discuss the question of a daily medical inspection of schools. Owing to the peculiar conditions which

obtain in Newton, the problem of a practical method is somewhat difficult of solution. A very important adjunct to the medical inspection would be the passing of a rule by the school committee requiring every child who has been absent from school for more than a certain time, say, three days, to present a certificate from the medical inspector of the district stating that it is safe for him to return to school. The scheme of inspection contemplates the supervision of contagious diseases only, and does not include in its scope such things as diseases of the eyes, nose or ears.

There was nothing resembling an epidemic of diphtheria during the year, and the total number reported was far below the number for the past five years, the yearly average for that period being 87.

Eighty-five cases of scarlet fever were reported during the year, with no deaths. A number of unreported cases were discovered during the late fall which caused some little trouble, as the children had been attending three different schools and all of these schools had to be disinfected.

A special item of $200 was added to the appropriation of the board of health for the examination of sputum in suspected cases of consumption.

The number of cases of typhoid fever reported during 1905 was 18, with 4 deaths, a rate of 22.22 per cent. The number of cases is much smaller than usual, the average for the past five years being 41.

The experiment of substituting galvanized iron barrels for the wooden ones formerly in use proved so successful that this year more of the iron barrels were purchased and the wooden barrels, most of which were in a badly dilapidated condition, were discarded. The iron barrels have stood the test of service better than the wooden tubs, being lighter, neater in appearance and much less expensive.

Particular attention has been given to the work of supervising the production and distribution of milk. As in previous years, each milk farm in the city where more than four cows are kept for the purpose of producing milk for public supply has been examined by the agent at least once each month, and farms where less than four cows are kept for the same purpose have been inspected at frequent intervals. Absolute cleanliness has been insisted on, and, on the whole, little difficulty has been encountered in securing the results desired.

The rules adopted by the board in 1904 for the regulation of the milk business have been put in force during the year, and with two exceptions all the dealers and producers in the city have unhesitatingly complied with its requirements.

It was felt advisable to subject outside milk farms sending their product into Newton, so far as possible, to the regulations imposed on local producers. With this purpose in view, a list was prepared of all farms and dealers sending milk into the city, and a systematic inspection

inaugurated. In all, 83 farms located in 19 different towns and cities have been visited and a total of 117 inspections made.

On the whole, the milk producers have shown entire willingness to comply with the regulations of the board, and as a result of the inspections a marked improvement in the condition of these farms has been noted. For failure to comply with the requirements of the board, the sale of milk from four farms was forbidden.

### North Adams.

During the year an act was passed forbidding the distribution of free samples of medicinal substances from house to house. The enforcement of that rule should receive the earnest coöperation of the police and citizens, as a practice of indiscriminate and careless distributing of deadly drugs in the doors and hallways of our homes is a danger not to be lightly regarded.

The board would again urge the need of a laboratory to carry on the work of this department. The arguments in favor of its establishment need not be repeated here. Such an institution has the endorsement both as to efficiency and economy in the practice of many of the cities of the Commonwealth.

The board also urges an early consideration of a contagious hospital, which could be made open to parents and visitors.

The question of sanitary barber shops has been carefully considered, and rules were adopted and placed in each shop whereby the patrons might learn the requirements of the board. The matter of enforcing such regulations is in the hands of the citizens, who alone are able to know whether or not there are violations of the law.

### Northampton.

In December, rules relating to plumbing and regulations regarding barber shops were adopted.

The city council having authorized an appropriation for a salary for a physician to the board of health, the appointment was made, and instructions given relative to making, without charge, bacteriological examinations in any case suspected of having diphtheria or pulmonary or laryngeal tuberculosis. At the same time the board made new regulations regarding the reporting of tuberculosis and the quarantining of diphtheria.

### Pittsfield.

The general health of the city for the past year has been excellent. There have been no epidemics of any character. It is believed by the board that this may, in a measure, be due to the improved sanitary conditions in the city, resulting from the large number of dwellings which

were connected with the sewer during the past year, and the thorough cleaning of premises adjacent to houses.

After considerable difficulty with some abutting landowners the board was able to abolish, as it believes, all drains discharging house refuse into the west branch of the Housatonic River, with the exception of Jordan Avenue, the condition of which will be remedied in the spring, when connections with the new sewer, laid through that street last autumn, can be enforced.

During the past year we have endeavored to enforce strictly the requirement of the laws in relation to sewer connections, which has resulted in the addition of 189 dwellings to the city's sewage system. This has not been accomplished without resort to drastic measures. Something like 40 persons have been summoned before the district court for failure to comply either with our orders or with the requirements of the ordinances. All of this number have either pleaded guilty or been so adjudged by the court, and in all but 3 cases the work desired has been accomplished. Three fines have been imposed upon the persons who failed to do the work ordered by the court and this board, and in these cases the work will be completed this spring. A thorough canvass has been made of all houses remaining unconnected, and notices have been served during the present year upon their owners requiring their compliance with the sewer regulations.

The board recommends the extension of the sewer system to the plants of all the large manufacturing companies as rapidly as the city can do the work.

The board particularly recommends that physicians and the public make a strong effort to assist in obtaining full information as to the existence of tuberculosis. It cannot be combated successfully without the coöperation of physicians and of the infected, and all known cases should be reported. The board will fumigate all houses where death has occurred or where a house has had a case of the disease in it, and will furnish printed directions for the care of patients.

## Salem.

Since July, the hospital for contagious diseases has been in use. It has proved its value and received the commendation of physicians.

The board is of the opinion that medical inspection of the schools should be undertaken; also that greater care should be paid to the protection of meats, fruits and vegetables exposed for sale out of doors. Attention is called to the greater care needed in handling milk. With this in view, the board believes that the law should be changed so that it shall be empowered to appoint and regulate the duties of a milk inspector.

### Somerville.

The board has adjudged that the diseases known as smallpox, scarlet fever, diphtheria, membranous croup, typhus fever, typhoid fever, chicken pox, pulmonary tuberculosis, cerebro-spinal meningitis and cholera are infectious, or contagious, and dangerous to the public health and safety within the meaning of the statutes. Physicians are required to report immediately to the board every case of either of these diseases and all cases of measles coming under their care, and postal cards conveniently printed and addressed are supplied to them for the purpose.

On May 17, 1901, the city purchased an estate in West Somerville for the purpose of establishing a contagious hospital. Nothing further was done until a year ago, when the agitation in favor of the project was renewed, and later on an appropriation of $5,000 was made by the board of aldermen for the purpose of converting the house in its present location into a contagious hospital. Work was begun early in the fall and the building is now nearly ready for occupancy. Forty or more persons can be accommodated at one time, and the facilities for taking care of them will be of the best and most modern character. Here patients may be taken when proper isolation or care is impossible at home, and thus will the prevalence of these diseases be better controlled and the public health be better protected.

### Springfield.

An attempt was made last year to secure from the city council an appropriation to enable the board to inaugurate a system of medical inspection of the school children of the city. Although the measure failed to pass, the board feels that this work should be undertaken by the city without further delay.

In December of 1905 the board voted to furnish the physicians of the city with facilities for free laboratory tests in suspected cases of typhoid fever. This work will be done by the bacteriologist of the board, and as soon as the necessary outfits are ready the physicians will be notified by circular. The board feels that in providing free laboratory facilities for the diagnosis and corroboration of cases of typhoid fever, diphtheria and tuberculosis, it is placing Springfield in the front rank with larger cities which have maintained such service for some years.

Much has been done during the past year to improve the quality of the milk supply of the city and the conditions under which milk is produced, so that a cleaner, safer product may be assured. During the fall, the State dairy inspector visited all the dairies from which Springfield received milk, in company with the city inspector of milk. Reports have been received from the State Board of Health as to the conditions of many dairies, and recommendations were made in certain instances.

Following out these suggestions, the board has excluded the milk from 12 dairies from being sold or distributed in the city until the sanitary conditions at these places were improved. Many other producers have received warning notices, and it is the intention of the board to do all in its power to improve the conditions under which milk is produced, sold and distributed.

In November, the board adopted a set of rules relative to the care and sale of milk, and these are now being distributed to producers, peddlers, contractors and dealers.

The success of the public playgrounds, instituted last summer by private enterprise, is much appreciated by the board. The carrying on of this scheme cannot but be beneficial to the smaller children, whose chief playgrounds heretofore have been the city streets.

A beginning has been made in the matter of official recognition of tuberculosis. Seventy-three cases of this disease have been reported to the board of health, which, while it does not begin to represent the total number of existing cases in the city, marks the beginning of the attempt to control its spread. Efficient methods of dealing with tuberculosis cannot be said to have been put forward as yet. An organized effort is, however, to be made this year to deal with this disease, and the greatest aid to the board will consist in the prompt reporting of such cases. Circulars as to the manner of spread of the disease, methods of disposal of the sputum, and other facts that both the sick and the well should know, are being prepared for distribution, and special cases will receive further advice and attention as needed. A hospital to which cases of tuberculosis could be sent, within easy reach of the city, would greatly assist in lessening the amount of exposure in many families.

More than usual work has been done in caring for premises where infectious diseases existed. This included placarding and obtaining a complete history of each case, together with the removal of the notification cards, the cleansing and fumigation of premises after the death or recovery of the patients. In this connection, service has been rendered to tuberculosis cases.

| | |
|---|---|
| **Number of houses fumigated,** . . . . . . . . . . | 302 |
| **Number of rooms fumigated,** . . . . . . . . . . | 883 |

### Waltham.

During the past year there was an unusual number of cases of typhoid fever reported, the total number being 98; of this number, 65 cases occurred in September, 19 cases in October and 7 cases in November, or 91 cases during the fall months.

During the month of September the board called upon the State Board of Health for assistance in finding the cause for the large number of

cases that were occurring. Careful investigation showed that 45 cases of typhoid fever occurred on the route of one milkman. Eleven other cases were traced to one boarding house.

These two sources of infection account for 56 cases, leaving 42 cases unaccounted for.

The average number of cases of typhoid fever in Waltham for the past five years has been 43.4 per year.

With the exception of typhoid fever, the city has been very free from infectious diseases.

### Ware.

In order to limit the spread of diphtheria the board has made active efforts, in coöperation with the school authorities, to learn of cases of throat trouble that had features suggesting investigation. It seemed best to employ a pathologist, from whom the board could get a diagnosis of the disease or a report of its absence as early as practicable. The avoidance of unnecessary quarantine and the early detection and isolation of the disease appears to be called for by public sentiment, even at the necessary cost for the clinical laboratory report.

Other diseases likely to occur among children at school have received attention of the school authorities during the last year and requests have been made for examination by the board when it seemed to be called for. Postal cards for use by physicians or householders, in compliance with the law, have been prepared in a revised form and sent to physicians.

In order to effectually limit the spread of disease, it has been found necessary, the past year, to prevent the sale of milk, the sale of meat and provisions in another instance, and again to require the destruction of a considerable number of school books which were considered dangerous for use.

### Wellesley.

This year a rule has been made and enforced by which indiscriminate collection of garbage has been discontinued, and its collection and disposal put wholly under the charge of the town.

Another rule has also been made prohibiting the keeping of swine within the residential district.

The board is glad to report that negotiations for stopping the pollution of Lake Waban by discharge into its inlet of the wastes from the paint mill have practically been completed, and it is expected that early in the spring this pollution will be permanently discontinued.

### Watertown.

Communicable diseases have been more or less prevalent during the year, and the board has been alert to the possibilities of epidemics, but none has occurred. This is due in no small measure to the carefulness of the medical inspectors and to the vigilance and care of the teachers in the public schools in separating from other children such as exhibit suspicious symptoms.

That the mosquito is the medium through which malarial fever is spread is now a matter of universal acceptance. In view of this fact the board employed an agent who periodically petrolized the breeding places of this pest throughout the mosquito season. A considerable sum was expended in the work which, however, resulted in an almost complete immunity from malaria.

In response to an urgent demand of the public for protection against the danger of the brown-tail moths, the board, under authority of chapter 75 of the Revised Laws of Massachusetts, issued an order adjudging the brown-tail moth a nuisance, and cause of sickness and dangerous to the public health.

The board has published, in connection with its annual report, several pages of "Health Suggestions," giving directions as to preventing the spread of tuberculosis, diphtheria, typhoid fever, scarlet fever and other contagious diseases.

### Westfield.

The board feels that the decrease in the number of contagious diseases for the past two years may be accredited in some degree to the manner of fumigation and the timely use of disinfectants in suspicious cases.

The board has had printed circulars of information and rules governing each contagious disease, and when quarantining a house a copy of this circular is left with some member of the family and a strict compliance with the same is insisted upon.

It has been decided that consumption must take its place with other contagious diseases; therefore, some provision must be made for treatment. The board recommends a tuberculosis hospital.

### Worcester.

One hundred and fifty cases of typhoid fever were reported during the year, with 26 deaths, a mortality of 17.33 per cent.

The number of cases in excess of last year, 46, is exactly the number reported in the epidemic which occurred in August.

On the 9th of August, word was received from one of the visiting physicians at the City Hospital that members of two different families

were sick with typhoid fever at the hospital. Both of these families were taking milk from the same milkman in Holden. An inspector was sent at once to Holden to investigate. He reported that a girl was sick in the family of the milkman with what the physician in attendance called heat prostration. No chances were taken, however, and the milkman was ordered to bring no more milk into Worcester until further notice. It was well this precaution was taken, for in the next two weeks 46 cases were reported, 9 of which died. A thorough investigation failed to disclose the initial case in this epidemic.

An outbreak of cerebro-spinal meningitis in an epidemic form occurred during the year. This department treated it as if it were one of the acute infectious diseases, requiring prompt burial, private funerals and disinfection after each case. Fourteen cases were reported, with 9 deaths.

The regular free vaccination of children was carried on, as usual, by the chairman. During 1905 there were 1,997 vaccinated.

The board feels that it cannot do better than to repeat its recommendation of last year relative to the medical inspection of schools.

The work of the isolation hospital during the past year has been, as always, commendable. The last two months of the year just closed have brought to the attention of the board the great need of some provision for mixed cases of infection, together with those sent of mistaken diagnosis. No less than 11 cases of diseases other than those regularly treated at the hospital were sent. Five of these were measles, the most contagious of all diseases. How to prevent these from contracting diphtheria or scarlet fever, and how to protect regular patients from such diseases, is a most difficult problem. It shows conclusively how imperative it is to have the addition built for which the board has been pleading for more than five years past.

The ninth annual report of the isolation hospital shows that the proportion of cases of diphtheria reported in the city in 1905 which came to the hospital was 63.63, as against 20.8 in 1897, and of scarlet fever, 28.0 in 1905, as against 7.0 in 1897. All infectious diseases assumed a more serious type in 1905 than for several preceding years, measles and diphtheria especially. The death-rate for the latter has not been as high since 1901, either for hospital or non-hospital cases, and the cause is not easily defined.

# INDEX.

# INDEX.

PUBLIC DOCUMENT . . . . . . . . No. 56.

# THIRTEENTH ANNUAL REPORT

OF THE

# BOARD OF REGISTRATION IN MEDICINE.

FOR THE YEAR ENDING DEC. 31, 1906.

BOSTON:
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1907.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

# Commonwealth of Massachusetts.

BOARD OF REGISTRATION IN MEDICINE,
STATE HOUSE, Dec. 31, 1906.

To His Excellency CURTIS GUILD, Jr., *Governor.*

SIR: — We have the honor to present the thirteenth annual report of this department.

### FINANCIAL STATEMENT.

*Expenditures.*

| | | |
|---|---|---|
| Services of members of Board, | $4,300 00 | |
| Incidental expenses of Board, | 547 90 | |
| Investigation of complaints, | 140 25 | |
| Clerical service, | 796 00 | |
| Printing and material, | 450 57 | |
| Books and other office supplies, | 255 81 | |
| Postage, expressage and telephone, | 166 07 | |
| | | $6,656 60 |

*Receipts.*

| | |
|---|---|
| Fees paid into the treasury of the Commonwealth, from 339 applicants for registration, | $6,780 00 |

The number of persons applying for registration during the year is 315, all of whom have been examined except 8. Of the number applying, 257 are graduates from medical schools authorized to confer degrees in medicine, and 58 were non-graduates. The percentage of graduates registered on first examination is 83+, and of non-graduates 27+. The percentage of both graduates and non-graduates registered during the year is 64+. The number of individual examinations given is 418. The results of the several examinations are tabulated as follows: —

| | Examined. | Registered. | Rejected. | Percentage rejected. |
|---|---|---|---|---|
| March examination, | 77 | 47 | 30 | 39 |
| May examination, | 47 | 22 | 25 | 53 |
| July examination, | 153 | 117 | 36 | 24 |
| September examination, | 74 | 45 | 29 | 40 |
| November examination, | 67 | 39 | 28 | 41 |
| | 418 | 270 | 148 | 39.4 |

The following tabulated data apply only to results in first examination of graduates: —

| NAME OF INSTITUTION. | Number examined. | Number registered. | Year of Graduation of Rejected Applicants. |
|---|---|---|---|
| Tufts College, | 57 | 55 | 1905-05. |
| Harvard University, | 55 | 53 | 1882-1906. |
| Baltimore Medical, | 23 | 11 | 1901-03-04-05-05-05-05-05-06-06-06-06. |
| Boston University, | 22 | 19 | 1906-06-06. |
| Physicians and Surgeons, Massachusetts, | 10 | 7 | 1905-05-06. |
| University of Vermont, | 8 | 7 | 1898. |
| Foreign, | 7 | 6 | 1904. |
| Woman's Medical, Pennsylvania, | 7 | 7 | |
| Johns Hopkins, | 7 | 7 | |
| Dartmouth, | 6 | 6 | |
| Baltimore University, | 6 | 1 | 1903-04-05-06-06. |
| University of Pennsylvania, | 6 | 6 | |
| Medical School of Maine, | 6 | 6 | |
| Laval, | 5 | - | 1904-05-06-05-06. |
| University of Michigan, | 5 | 5 | |
| Physicians and Surgeons, Maryland, | 3 | 2 | 1906. |
| Albany Medical, | 3 | 2 | 1892. |
| Yale, | 3 | 3 | |
| Maryland Medical, | 3 | 1 | 1905-06. |
| University of the South, | 3 | 1 | 1903-06. |
| Jefferson, | 2 | 2 | |
| Hahnemann, Pennsylvania, | 2 | 2 | |
| McGill, | 2 | 2 | |
| Physicians and Surgeons, New York, | 2 | 2 | |

| NAME OF INSTITUTION. | Number examined. | Number registered. | Year of Graduation of Rejected Applicants. |
|---|---|---|---|
| Kentucky School of Medicine, | 2 | 1 | 1904. |
| Leonard Medical College, | 2 | 1 | 1905. |
| National Medical University, | 2 | 1 | 1904. |
| University of Georgetown, | 1 | 1 | |
| University of Maryland, | 1 | 1 | |
| Long Island College Hospital, | 1 | 1 | |
| Medico-Chirurgical, Pennsylvania, | 1 | 1 | |
| Illinois Medical College, | 1 | - | 1902. |
| New York Homœopathic Medical College, | 1 | 1 | |
| Physicians and Surgeons, Iowa, | 1 | 1 | |
| Eclectic Medical College, New York, | 1 | - | 1906. |
| Bellevue Hospital Medical College, | 1 | 1 | |
| Cornell, | 1 | 1 | |
| Rush Medical, | 1 | 1 | |
| Eclectic Medical Institute, Ohio, | 1 | 1 | |
| Bennett Medical College, | 1 | 1 | |
| University of Virginia, | 1 | 1 | |
| University Medical College, Kansas City, | 1 | - | 1899. |

Tabulation showing number and average rating of graduates from the following medical schools, represented by not less than three applicants: —

| NAME OF INSTITUTION. | Number examined. | Average Rating. |
|---|---|---|
| Tufts College, | 57 | 74.4 |
| Harvard University, | 55 | 75.2 |
| Baltimore Medical, | 28 | 61.9 |
| Boston University, | 22 | 73.4 |
| Physicians and Surgeons, Massachusetts, | 10 | 67.4 |
| University of Vermont, | 8 | 72.9 |
| Foreign, | 7 | 72.7 |
| Woman's Medical, Pennsylvania, | 7 | 77.4 |
| Johns Hopkins, | 7 | 78.2 |
| Dartmouth, | 6 | 75.4 |
| Baltimore University, | 6 | 58.8 |
| University of Pennsylvania, | 6 | 75.6 |
| Medical School of Maine, | 6 | 71.8 |

| Name of Institution. | Number examined. | Average Rating. |
|---|---|---|
| Laval, | 5 | 55.5 |
| University of Michigan, | 5 | 75.6 |
| Physicians and Surgeons, Maryland, | 3 | 73.7 |
| Albany Medical, | 3 | 69.3 |
| Yale, | 3 | 77.4 |
| Maryland Medical, | 3 | 65.0 |
| University of the South, | 3 | 67.1 |

Applicants are admitted to examinations by an "examination ticket," showing the date of the examination, and the holder's application number. Tickets are issued to applicants at the time of filing their applications; also to rejected applicants entitled to a re-examination, if applied for not later than five days before the examination date. Examinations are conducted in writing, in the English language only. Incognito ratings are insured by the requirement that applicants shall use their application number only, in designating their answer papers.

The three examinations in a year, provided by law, begin respectively on the second Tuesday in March, July and November. Special meetings for conducting examinations have been held in May and in September, as in previous years. The time devoted to each examination has been two full days. It is now the purpose of the Board to extend the time next year to three days, and to increase the number of exercises from six to seven. The complaint has often been made by applicants that sufficient time is not allowed in which to answer to their satisfaction ten comprehensive questions on general surgery, for instance, or ten questions dealing with diagnosis and therapeutics. By devoting three days to examination work, two hours and a half, instead of two, as heretofore, can be allowed for each of several of the exercises.

In each of the examinations next year 70 questions will be asked, grouped in sets of 7. Answers will be rated on a scale of 0 to 100, and examinations will be classed as unsatisfactory when general averages fall below 75 per centum.

The questions are intended to be practical, and to cover substantially the instruction given in the medical schools in this

country in a four years' course. The subjects on which the examinations are principally conducted are anatomy and histology, physiology and hygiene, pathology and bacteriology, surgery, obstetrics and gynecology, diagnosis and therapeutics, and pediatrics and toxicology.

The aim of the Board is to conduct its examination work in a manner best adapted for determining the qualifications of applicants. Its practice is to conduct the examination of recent graduates and non-graduates wholly in writing. Applicants coming from without the Commonwealth, who furnish evidence of having conducted a reputable practice for not less than ten years, may be admitted to a special examination, largely oral. It is the belief of the Board that such an examination for practitioners of several years' standing is best adapted to meet the requirements of the law, and is far more likely to be just.

Previous to this year the Board admitted applicants who had received their medical training in foreign schools, and who could not speak or write in other than their native language. Such applicants were allowed to write their papers in their own language, on condition that they would pay the cost of translations secured by the Board for the purpose of rating; but, there being some doubt as to the legality of examinations conducted in this manner, the opinion of the Attorney-General of the Commonwealth was requested. His opinion, printed in the Appendix, being adverse to such procedure, only those who can write in English are now admitted.

If Massachusetts covets the reputation of aiming to uphold high standards in the medical school and in the medical profession, the laws of the Commonwealth should enable the Registration Board to conduct its examinations on lines followed by nearly all the other States. In one important particular the Massachusetts law is defective. It is obvious that examining boards should work in conjunction and in harmony with medical schools, in order to secure the best attainable results in their efforts to determine the fitness of applicants to serve the public professionally. But this is not the condition of affairs with us. Persons who have not pursued even a partial course of study in a reputable medical school, who have had no clinical instruction, who know nothing of laboratory demonstrations and who

have had no practical experience in the hospital, are permitted to take the Board examination in this State. Such applicants, simply from a superficial knowledge derived from medical compends, or by memorizing hand-books of answers to questions asked or likely to be asked by the examining boards, may succeed in passing an appropriate examination before any State Board, and yet be grossly unfit to assume the responsibilities of a physician. Herein lies danger to life and health. In forty States and Territories this danger has been recognized, and guarded against by legislative enactments. Why should Massachusetts, in company with Arkansas, Mississippi and Tennessee, still loiter in the background of progress in the medical world?

The Board of Registration would indeed be wanting in duty to the public should it not again call the attention of the Legislature to this important matter, and again recommend the enactment of amendments to the registration act, requiring applicants for a license to practise medicine to furnish satisfactory evidence of having graduated from a reputable school of medicine, as a prerequisite of admission to an examination.

The word "medicine," as used in the registration act, is susceptible of but one meaning, namely, "the science which relates to the prevention, cure or alleviation of disease." The law does not consider methods or systems of practice, — whether one does or does not make use of drugs in treatment. It explicitly states that its provisions "shall not be held to discriminate against any particular school or system of medicine." Practising medicine within the meaning of the law consists in treating the sick for the purpose of cure; and a practitioner of medicine is one who makes it his business so to do. Not infrequently, however, certain practitioners claim that they are not practitioners of medicine, because in their method of practice they use no "medicine." Notwithstanding the absurdity of the claim, it is often used to distract and hinder court proceedings in prosecution cases.

Just what constitutes the practice of medicine, or holding one's self out as a practitioner of medicine, is clearly set forth in the medical practice laws in the other States. Such definitions have their advantages; possible misinterpretations of the in-

tended meaning of the law are thereby avoided; its administration is simplified, and more certain as to results; and violations of it are less likely to occur. An amendment to the law, drawn substantially as follows, is earnestly recommended: —

Any person shall be regarded as practising medicine within the meaning of section eight of chapter seventy-six of the Revised Laws, who shall publicly assume or advertise any title or designation which shall show or tend to show that the person publicly assuming or advertising the same is a practitioner of medicine in one or more of its branches; or who shall investigate or diagnose physical ailments, defects or conditions of any person, with a view to treat or relieve the same, or does treat the same, by any method or system of practice, whether with or without the use of drugs.

The last part of section 9 of chapter 76 of the Revised Laws, beginning with the words "nor to registered pharmacists," is frequently misunderstood or misapplied, due to the fact, no doubt, that the force of the proviso in the last line of the section is not strictly regarded. Clearly it was not the intention of the Legislature to exempt the several classes of persons mentioned in this part of the section from the general provisions of the law, only so far as they may be able to perform certain functions without infringing upon the terms of section 8. It is well understood that there are certain acts relating to the treatment of the sick which osteopaths, so called, or massagists, etc., may perform without holding themselves out as practitioners of medicine, or without being considered as practising medicine within the meaning of the law; for instance, rendering certain services to the sick, or administering treatment generally under the direction of, or as advised by, attending physicians. But such services do not require the sanction of law. Inasmuch, therefore, as this part of section 8 does not confer special rights or privileges on the classes mentioned therein, it would be wise for the Legislature to repeal it, in order to avoid possible misapprehensions regarding it.

Numerous complaints of violations of the registration law have been investigated this year, and fourteen prosecutions have resulted in conviction. Several persons holding themselves out as midwives, without registration as physicians, and practising

only as obstetricians, have been convicted of violating the law. An appeal from one such conviction is now pending in the Supreme Court. The question raised by the defendant is, whether one practising midwifery as a specialty is included within the statute; in other words, whether midwifery is a branch of medicine. For an opinion of the Supreme Court of Illinois on this precise question, see People *v.* Arendt, 60 Ill., App. 89.

Four certificates of registration, numbered respectively 1160, 2719, 3684 and 6395, have been revoked; and the registration of their holders, all of whom had been sentenced for criminal malpractice, has been cancelled.

Since the organization of this department, in July, 1894, the Board has issued 8,043 certificates of registration. Of this number 3,792 were issued prior to January, 1895, during the six months next following the organization of the Board, to physicians practising in the Commonwealth at the time the registration act became in part operative. There were 608 persons refused registration during the six months above referred to, they being unable to meet the requirements of the law as to graduation, or as to three years of continuous practice in this Commonwealth next prior to the passage of the law.

The work of registration under written examinations, conducted by the Board as required by law, began with the year 1895. Since that time the Board has given 5,739 individual examinations and has issued 4,249 certificates of registration, — an annual average of 354. The number of unsatisfactory examinations is 1,490, — an annual average of 116.

The number of registered physicians now in practice in the Commonwealth is approximately 5,300.

Respectfully submitted,

C. EDWIN MILES, *Chairman.*
EDWIN B. HARVEY, *Secretary.*
WALTER P. BOWERS.
SAMUEL H. CALDERWOOD.
AUGUSTUS L. CHASE.
NATHANIEL R. PERKINS.
AUGUSTUS C. WALKER.

# APPENDIX.

# APPENDIX.

## Law relating to the Registration of Physicians.

[Revised Laws, Chapter 76, Sections 1-9.]

Section 1. There shall be a board of registration in medicine consisting of seven persons, residents of this commonwealth, who shall be graduates of a legally chartered medical college or university having the power to confer degrees in medicine, and who shall have been for ten years actively employed in the practice of their profession. No member of said board shall belong to the faculty of any medical college or university, and no more than three members thereof shall at one time be members of any one chartered state medical society. One member thereof shall annually in June be appointed by the governor, with the advice and consent of the council, for a term of seven years from the first day of July following.

Section 2. Said board shall hold regular meetings on the second Tuesday of March, July and November in each year, and additional meetings at such times and places as it may determine. At the regular meeting in July, it shall organize by the choice of a chairman and secretary who shall hold their offices for the term of one year. The secretary shall give a bond to the treasurer and receiver general in the penal sum of five thousand dollars, with sufficient sureties to be approved by the governor and council, for the faithful performance of his official duties.

Section 3. Applications for registration shall be made upon blanks to be furnished by the board, and shall be signed and sworn to by the applicants. Each applicant for registration shall furnish satisfactory proof that he is twenty-one years of age or over and of good moral character and, upon payment of a fee of twenty dollars, shall be examined by said board. If he is found by four or more members thereof to be twenty-one years of age or over, of good moral character and qualified, he shall be registered as a qualified physician and shall receive a certificate thereof signed by the chairman and secretary. An applicant who fails to pass an examination satisfactory to the board, and is therefore refused registration, shall be entitled within one year after such refusal to a re-examination at a

meeting of the board called for the examination of applicants, without the payment of an additional fee; but two such re-examinations shall exhaust his privilege under his original application. Said board, after hearing, may by unanimous vote revoke any certificate issued by it and cancel the registration of any physician who has been convicted of a felony or of any crime in the practice of his profession. All fees received by the board shall, once in each month, be paid by its secretary into the treasury of the commonwealth.

[SECTION 4.[1] Each member of the board shall receive ten dollars for every day actually spent in the performance of his duties, and the necessary travelling expenses actually expended in attending the meetings of the board, not exceeding three cents a mile each way. Such compensation and the incidental and travelling expenses shall be approved by the board and paid by the commonwealth only from the fees paid over by the board.]

SECTION 5. The board shall keep a record of the names of all persons registered hereunder, and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor of the condition of medicine and surgery in this commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

SECTION 6. The board shall investigate all complaints of the violation of the provisions of section eight, and report the same to the proper prosecuting officers.

SECTION 7. Examinations shall be wholly or in part in writing in the English language, and shall be of a scientific and practical character. They shall include the subjects of anatomy, surgery, physiology, pathology, obstetrics, gynecology, practice of medicine and hygiene, and shall be sufficiently thorough to test the applicant's fitness to practise medicine.

SECTION 8. Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches, or whoever practises medicine or surgery under a false or assumed name, or under a name other than that by which he is registered, or whoever personates another practitioner of a like or different name, shall, for each offence, be punished by a fine of not less than one

[1] Repealed by the Acts of 1902, and fixed salaries established.

hundred nor more than five hundred dollars, or by imprisonment for three months, or by both such fine and imprisonment. In a case in which a provision of this or the preceding section has been violated, the person who committed the violation shall not recover compensation for services rendered.

SECTION 9. The provisions of the eight preceding sections shall not be held to discriminate against any particular school or system of medicine, to prohibit medical or surgical service in a case of emergency, or to prohibit the domestic administration of family remedies. They shall not apply to a commissioned medical officer of the United States army, navy or marine hospital service in the performance of his official duty; to a physician or surgeon from another state who is a legal practitioner in the state in which he resides, when in actual consultation with a legal practitioner of this commonwealth; to a physician or surgeon residing in another state and legally qualified to practise therein, whose general practice extends into the border towns of this commonwealth, if such physician does not open an office or designate a place in such towns where he may meet patients or receive calls; to a physician authorized to practise medicine in another state, when he is called as the family physician to attend a person temporarily abiding in this commonwealth; nor to registered pharmacists in prescribing gratuitously, osteopathists, pharmacists, clairvoyants, or persons practising hypnotism, magnetic healing, mind cure, massage, Christian science or cosmopathic method of healing, if they do not violate any of the provisions of section eight.

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### COMMONWEALTH v. ST. PIERRE.

This is a case in which a person in Fall River was accused of practising medicine without registration. His professional sign was that of an "eye specialist." He was sentenced in the municipal court to three months' imprisonment and to pay a fine of five hundred dollars, the maximum penalty. The case was carried to the superior court, where sentence was sustained; but certain exceptions were taken by the defendant's counsel to the rulings of the court. The exceptions were finally disposed of in the following opinion of the supreme judicial court, rendered on the thirteenth day of December, 1899: —

LORING, J. The exception to the exclusion of testimony offered by the defendant on cross-examination must be sustained. The government had introduced in evidence testimony of a number of persons to the effect that

they had visited the defendant at various times; that he gave to them medicines, and advised them how to use them; that at these times they had conversations with him about the nature of their complaints; that he afterwards visited some of them at their houses and treated them there, and that they paid him money; and the bottles and packages, which the witnesses testified were given to them, had been put in evidence.

The defendant offered to prove that "each and every occasion at the time the parties were told by the defendant that he was not a doctor, and that he did not charge anything for his services." This evidence was excluded.

If the defendant sold the medicines, receiving payment therefor, and gave advice gratuitously as to the use to be made of them, he was not, so far as those instances were concerned, holding himself out as a physician; his declarations accompanying the acts and showing the character of them were admissible as part of the *res gestæ*.

Of course it was open to the government to contend that in these instances he was really acting as a physician, and was paid as such for his services, and that these statements were efforts to evade the statutory provisions here in question.

But when the Commonwealth put in testimony to the effect that he had given directions and advice as to the use of the contents of the packages and bottles sold by him, and had been paid by the persons to whom the contents were sold, it was the right of the defendant to prove that in each instance he was paid not for the advice but only for the drugs, and that he declared that he was not a physician; and in that way to raise the question whether, so far as these instances were concerned, he was selling the drugs and giving information gratuitously as to their use, and therefore not thereby holding himself out as a physician, or whether he was really acting as a physician, taking payment therefor, and was seeking by such declarations to evade the effect of his actions. This question was a question for the jury, under all circumstances, and the testimony offered should have been admitted.

As the questions involved in the other exceptions may arise in a new trial, they may be briefly disposed of here: —

2. The burden was on the defendant to show that he was a registered physician, if he relied on such a justification. (Pub. Sts., c. 214, § 12.) This applies to cases where the absence of a license is made part of a description of the offence. (Commonwealth *v.* Kelly, 10 Cush. 69; Commonwealth *v.* Tuttle, 12 Cush. 502; Commonwealth *v.* Barnes, 138 Mass. 152; Commonwealth *v.* McCarthy, 141 Mass. 420.)

3. Proof that the defendant acted either as a physician or surgeon was sufficient to support the complaint, which charged him with holding himself out as a physician and surgeon. There is but one offence, and that may be committed by the defendant's holding himself out as a physician or a surgeon; if the complaint charges that the offence is committed by the defendant's holding himself out both as a physician

and surgeon, the whole offence is proved if he is shown to have held himself out as either. (Commonwealth *v.* Dolan, 121 Mass. 374.)

4. The ruling that, if the defendant held himself out as an eye specialist, he held himself out as "one who devoted himself to a branch of the healing art which is the profession of the physician and surgeon," and that "if the defendant held himself out as an eye specialist, he held himself out as a physician and surgeon within the meaning of the statute," was correct.

*New trial ordered.*

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## Commonwealth *v.* Maddalina Della-Russo.

The complaint against Della-Russo, a midwife, was that she held herself out as a practitioner of medicine; and that she practised medicine unlawfully. In the lower court, Suffolk County, William J. Forsaith, justice, she was adjudged guilty on both counts. An appeal was taken and the case was tried in the superior court, December term, 1904. Verdict, guilty on both counts. The contention of the defendant's counsel was that in holding herself out as a midwife she did not hold herself out as a practitioner of medicine, and that in her practice she attended only normal cases of labor, and in so doing she acted in the capacity of a nurse only.

Robert O. Harris, justice, charged the jury as follows: —

In the consideration of this case, it is well for the jury in the beginning to start upon their deliberations with a well-defined idea of what the issue is. This complaint charges the defendant in two counts; first, with holding herself out as a practitioner of medicine; second, as having practised medicine. The statute under which we are proceeding provides that, "Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches," shall be subject to a certain penalty. This statute, enacted in 1894, may be said to be a re-enactment, in a little different shape and with wider scope, of laws which had been on the statute books of this commonwealth for many years. Under the old law there arose the question which has been raised in this case, as to whether it is necessary that a person should hold himself out to practise medicine generally in order to come within the purport of the statute. Under the early statute, in 1835, Chief Justice Shaw of the supreme court rendered an opinion as follows: —

The first question for the court is whether, upon the facts agreed, the defendant can be held to be engaged in the practice of physic or surgery. It appears that he professes and practises bone setting and reducing sprains, swellings and contractions

of the sinews, by friction and fomentations; but no other department of the curing art. By bone setting we understand the relief afforded as well in cases of dislocation as in those of fracture. The court are of the opinion that this brings him within the meaning of the statute as one who practises physic or surgery. We think it not necessary for one to profess to practise generally, either as a physician or surgeon, to bring him within the operation of this statute, but that it extends to any one engaging in practice in a distinct department of either profession, and that the defendant's practice forms a considerable department in the practice of surgery.[1]

That is to say, if one holds himself out to practise or practises in any line of endeavor which comes within the territory which belongs to medicine, he comes under this act, although he may follow a specialty.

But this precise question as to whether midwifery is included within the statute has been directly decided in another Commonwealth, under a statute very similar in terms to ours. The case was a complaint against a woman for practising midwifery. The supreme court of that State said: —

It appeared from the proof that the defendant held herself out as a midwife and practised in that capacity. It is urged this is not a violation of the act. We think very clearly it is. Midwifery is an important department of medicine, and is so recognized by the act. The law-making power of the State has enacted that "No person shall practise medicine in any of its departments in this State without the qualifications required by this act." The validity of such a law is not denied, but it is urged only that the defendant had not practised medicine within the meaning of the act. It needs no argument to show the importance of obstetrics as a department of medicine, nor the necessity that those who assume to practise in that department should possess due knowledge and skill. The welfare of their patients is certainly within the purview of the law, no less than in other departments, where, in many instances, at least, even less care and skill may be essential, and where the consequence of ignorance and unskillfulness may be less unfortunate.[2]

Under the rulings in these cases to which I have referred, and under the law as I understand it, I shall have to instruct you that as a matter of law one who undertakes to practise midwifery is one who is undertaking to practise medicine. The issue in this case is, therefore, whether this defendant has undertaken to practise as midwife. If so, she is within the language of the act, because she has undertaken to practise medicine, or a branch thereof.

The question, then, in this case narrows itself down to just what this defendant did. She claims that she did not hold herself out to practise in any other way than as a mere nurse; and that she assumed no responsibilities in anything that she did in any case other than those of an ordinary trained or skilled nurse. And upon that issue you have to consider the evidence in the case. If all she did was to act simply as a nurse, acting under somebody else's directions, and doing only those things which a mere nurse ordinarily does, and assuming no responsibility

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[1] Hewitt v. Charier, 16 Pickering, 353. [2] People v. Arendt, 60 Ill. App. 89.

for anything excepting that she should do the things well as a nurse, then she is not guilty under this complaint. If, however, while calling herself a nurse she actually assumed the function of a physician, and advertised herself as being competent to perform the duties of an ordinary physician, and was engaged upon that understanding, then you will be warranted in finding her guilty.

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## Opinion of the Attorney-General relative to the Examination of Applicants unable to write in English.

OFFICE OF THE ATTORNEY-GENERAL, BOSTON, Feb. 13, 1906.

EDWIN B. HARVEY, M.D., *Secretary, Board of Registration in Medicine.*

DEAR SIR: — I beg to acknowledge the receipt of your favor of the 9th. Your Board requests the opinion of the Attorney-General as to the legality of conducting examinations of applicants for registration in other than the English language, provided that the applicant offers to pay for the services of a translator to translate his written papers into English.

Revised Laws, chapter 76, section 7, provides that —

> Examinations shall be wholly or in part in writing in the English language, shall be of a scientific and practical character, shall include the subjects of anatomy, surgery, physiology, pathology, obstetrics, gynecology, practice of medicine and hygiene, and shall be sufficiently thorough to test the applicant's fitness to practice medicine.

The question raised is, whether an examination in writing in some language other than English, the examination papers being translated by an interpreter at the expense of the applicant, is in compliance with the requirements of this statute.

The Legislature evidently intended that all persons permitted to practise medicine in this Commonwealth should have some knowledge of the English language. An examination in writing in the English language is, therefore, a test of the general qualifications of the applicant, as distinguished from his strictly technical qualifications. The statutes contemplate that each applicant shall show both general and technical qualifications. Whether or not a person who is unable to write English ought to be permitted to practise medicine in this Commonwealth, where English is the language commonly employed, is not for me to determine. It is clear, however, that there are many reasons which make it desirable that a

person practising medicine should have some familiarity with English, and that a requirement of some knowledge of that language is not unreasonable. The natural meaning of the statute is that papers shall be written in English, and no reason appears why the construction should be strained to give the words some other meaning. If this interpretation seems to work hardship, it may be noted that the Board has considerable discretion as to how large a part of the examination shall be in writing.

I am of the opinion that examinations must be, at least in part, in writing in the English language, not only when they come to the attention of the examining Board, but even when they leave the hands of the persons examined. I am therefore of the opinion that the suggested procedure is not permissible.

Very truly yours, DANA MALONE,
*Attorney-General.*

PUBLIC DOCUMENT . . . . . . . . No. 38.

# TWENTIETH ANNUAL REPORT

OF THE

# MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY.

FOR THE YEAR 1906.

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The State Board of Publication.

## MEMBERS OF THE

# MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY.

**1906.**

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| | |
|---|---|
| JOHN F. DOWSLEY, D.D.S., *President*, . . . . . . . | Boston. |
| GEORGE E. MITCHELL, D.D.S., *Secretary*, . . . . . . | Haverhill. |
| THOMAS J. BARRETT, D.D.S., . . . . . . . . . | Worcester. |
| GEORGE A. MAXFIELD, D.D.S., . . . . . . . . | Holyoke. |
| WILLIAM W. MARVEL, D.M.D., . . . . . . . . | Fall River. |

# Commonwealth of Massachusetts.

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BOARD OF REGISTRATION IN DENTISTRY, Dec. 30, 1906.

To His Excellency CURTIS GUILD, Jr., *Governor.*

SIR: — In compliance with the requirements of section 6, chapter 137 of the Acts of 1887, establishing a Board of Registration in Dentistry, we have the honor to submit to you the twentieth annual report, for the year ending Dec. 31, 1906.

The commissions of John F. Dowsley, D.D.S., of Boston, and George E. Mitchell, D.D.S., of Haverhill, having expired, they were reappointed as members of the Board for three years, and qualified according to law.

Dwight M. Clapp, D.M.D., of Boston, a member of this Board since 1896, died September 20. His years of service have been signally marked by untiring devotion to the duties intrusted to him by the State. He was equable and just to all, an excellent examiner and a wise counsellor, with a high sense of honor and consistency at all times, which characterized his public, professional and private life. William W. Marvel, Jr., D.M.D., of Fall River, was appointed to fill the vacancy. He qualified and entered upon his duties as an examiner October 26.

Three meetings have been held in Boston for examinations since our last report, on March 6, 7 and 8, June 26, 27 and 28, and October 23, 24 and 25. The result of these examinations is shown in tabular form as follows: —

*March Examinations.*

| | | | |
|---|---|---|---|
| Passed on first examination, | 21 | Rejected on first examination, | 22 |
| Passed on second examination, | 3 | Rejected on second examination, | 2 |
| Passed on third examination, | 6 | Rejected on third examination, | 6 |
| Passed on fourth examination, | 1 | Rejected on fourth examination, | 2 |
| Passed on fifth examination, | 1 | Rejected on fifth examination, | 3 |
| Passed on sixth examination, | 2 | Rejected on sixth examination, | 1 |
| | | Rejected on eighth examination, | 2 |
| Total, | 34 | Total, | 38 |

*June Examinations.*

| | | | |
|---|---|---|---|
| Passed on first examination, | 49 | Rejected on first examination, | 25 |
| Passed on second examination, | 13 | Rejected on second examination, | 7 |
| Passed on third examination, | 2 | Rejected on fourth examination, | 5 |
| Passed on fifth examination, | 1 | Rejected on fifth examination, | 1 |
| Passed on sixth examination, | 2 | Rejected on sixth examination, | 1 |
| Passed on seventh examination, | 1 | Rejected on eighth examination, | 1 |
| Passed on ninth examination, | 1 | | |
| Total, | 69 | Total, | 40 |

*October Examinations.*

| | | | |
|---|---|---|---|
| Passed on first examination, | 6 | Rejected on first examination, | 2 |
| Passed on second examination, | 12 | Rejected on second examination, | 8 |
| Passed on third examination, | 1 | Rejected on third examination, | 4 |
| Passed on fourth examination, | 1 | Rejected on fourth examination, | 2 |
| Passed on fifth examination, | 1 | Rejected on fifth examination, | 1 |
| | | Rejected on sixth examination, | 1 |
| | | Rejected on seventh examination, | 1 |
| Total, | 21 | Total, | 19 |

*Recapitulation.*

| | |
|---|---|
| Whole number examined for the year, | 228 |
| Whole number passed for the year, | 131 |
| Whole number rejected for the year, | 97 |

| | | | |
|---|---|---|---|
| Passed on first examination, | 83 | Rejected on first examination, | 49 |
| Passed on second examination, | 28 | Rejected on second examination, | 17 |
| Passed on third examination, | 9 | Rejected on third examination, | 10 |
| Passed on fourth examination, | 2 | Rejected on fourth examination, | 9 |
| Passed on fifth examination, | 3 | Rejected on fifth examination, | 5 |
| Passed on sixth examination, | 4 | Rejected on sixth examination, | 3 |
| Passed on seventh examination, | 1 | Rejected on seventh examination, | 1 |
| Passed on ninth examination, | 1 | Rejected on eighth examination, | 3 |
| Total, | 131 | Total, | 97 |

Of those not attending a dental college, 6 passed and 27 were rejected.

| | | | |
|---|---|---|---|
| Passed on first examination, | 3 | Rejected on first examination, | 10 |
| Passed on second examination, | 2 | Rejected on second examination, | 7 |
| Passed on third examination, | 1 | Rejected on third examination, | 2 |
| | | Rejected on fourth examination, | 3 |
| | | Rejected on fifth examination, | 2 |
| | | Rejected on sixth examination, | 2 |
| | | Rejected on seventh examination, | 1 |
| Total, | 6 | Total, | 27 |

Of those examined this year, 195 had attended a dental college; 33 had not attended a dental college.

All the examinations are absolutely impartial, practical in their character, and with paramount regard to matters which will fairly test the relative capacity and fitness of the persons examined for the service which they seek to enter.

The Board of Dental Examiners, though chiefly an examining Board, have taken it upon themselves to assist the proper authorities throughout the State in the enforcement of the dental law. In order that the public may be protected from fraud and incompetency, it becomes the duty of every licensed or registered practitioner to report by letter to the Board any violation of the law that he knows to exist. The Board will in turn present the case to the district attorney in the county where the violation occurs, so that he may investigate, and, if necessary, prosecute the case. Violations of the law in eight cases were brought to the attention of the Board during the year. These were properly complained of and prosecuted in the courts by the regular officers of the law, and each fined $50 and costs.

The meetings for examination of candidates during 1907 will be held in Boston, March, June and October. Special notice of examinations are published in the dental journals one month preceding each meeting, also, with application blanks, furnished by the secretary upon request.

FINANCIAL STATEMENT.

| | |
|---|---|
| Fees from applicants received and paid into the treasury of the Commonwealth, | $2,970 00 |
| Expenditures, | 3,488 50 |

Appended is a list in alphabetical form of deaths reported to the Board during the year.

All of which is respectfully submitted,

JOHN F. DOWSLEY, *President.*
G. EVERETT MITCHELL, *Secretary.*

## List of Deaths reported to the Board during the Year 1906–07.

| | |
|---|---|
| Chandler, Bartlett B., . . . . 1907 | Leavitt, William P., . . . . 1906 |
| Clapp, Dwight M., . . . . 1906 | O'Connor, James H., . . . . 1906 |
| Day, Alphonso M., . . . . 1906 | Starbuck, Edward P., . . . . 1906 |
| Ford, J. J., . . . . . . . 1907 | Vinall, George A. W., . . . . 1906 |
| Hamlin, Edward L., . . . . 1906 | White, Edward J., . . . . 1906 |
| Hitchcock, J. Evarts, . . . . 1906 | Williams, Jacob L., . . . . 1906 |

PUBLIC DOCUMENT . . . . . . . . No. 39.

# TWENTY-FIRST ANNUAL REPORT

OF THE

# MASSACHUSETTS BOARD OF REGISTRATION IN PHARMACY,

FOR THE

## YEAR ENDING SEPTEMBER 30, 1906.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1907.

Approved by
The State Board of Publication.

# CONTENTS.

## NAMES OF BOARD AND OFFICERS.

---

HENRY ADAMS, *President.*
WM. F. SAWYER, *Secretary.*
FRED A. HUBBARD.
LUCIAN A. LAMSON.
CHARLES N. SWIFT.

---

JOSEPH E. BUSWELL, *Agent.*

# Commonwealth of Massachusetts.

## REPORT.

To His Excellency CURTIS GUILD, Jr., *Governor.*

In compliance with the laws of the Commonwealth, we have the honor to submit the following report.

The general condition of pharmacy in the Commonwealth will compare favorably with previous years. A canvass of the State shows that this has been a prosperous year with the pharmacist, with but a few exceptions due to local causes.

At the last session of the Legislature an act was passed giving registered pharmacists, in cities and towns where licenses for the sale of intoxicating liquors of the first five classes are not granted, the right to sell liquor upon the prescription of a registered physician practising in such city or town, he having been granted a certificate of fitness from this Board. These certificates were granted in 55 cities and towns, and reports from a majority show the exercise of this privilege has been generally satisfactory, meeting with the approval of the officials of these cities and towns.

At the annual meeting of the National Association of Boards of Pharmacy, held in Indianapolis, Ind., in September, this Board was represented by Charles N. Swift and Fred A. Hubbard. The following is a report of the delegates: —

MR. PRESIDENT: — Upon recommendation of the Massachusetts Board of Registration in Pharmacy, His Excellency the Governor appointed two delegates to the National Convention of Boards of Pharmacy, said convention to be held at Indian-

apolis, Ind., during the week beginning Sept. 4, 1906, at Claypool Hotel. Your delegates beg leave to submit the following report: —

Seven sessions were held, and nearly every State and Territory was represented by delegates. President J. A. Keith of South Dakota presided, and Dr. G. E. Diekman of New York was secretary *pro tem.*

The president of the association read an address, which was referred to a committee. The committee reported to the convention with recommendations, which were discussed and adopted. Nearly a whole session was consumed in this discussion, and a committee on resolutions was appointed to hasten the work; said committee rendered the following report, which was adopted: that a committee of five be elected from the floor every year, for the purpose of preparing examination questions for a guide to the boards of pharmacy throughout the country. The following were elected: G. C. Diekman, New York; W. R. Ogier, Ohio; G. F. Payne, Georgia; C. N. Swift, Massachusetts; and D. F. Jones, South Dakota.

The recommendations of the joint conference of pharmaceutical faculties and boards of pharmacy were presented and discussed in full, occupying two whole sessions; and the secretary of the convention was instructed to have printed in proper form the provisions as adopted, and send to the constituent boards of pharmacy when completed.

The election of officers for the ensuing year was as follows: president, F. C. Godbold, Louisiana; first vice-president, F. A. Hubbard, Massachusetts; second vice-president, Chas. B. Woodward, Indiana; third vice-president, Kittie W. Harbord, Oregon; secretary-treasurer, Geo. C. Diekman, New York; examination committee, John D. Muir, Wisconsin.

Very respectfully yours,

CHAS. N. SWIFT,
FRED A. HUBBARD,
*Delegates.*

We would recommend slight changes in the pharmacy laws, namely, in section 16, chapter 76, we would recommend that the fifteen days' limit for making complaints be extended to "thirty days after final conviction in courts having competent jurisdiction."

We would also recommend that section 21, chapter 100, be amended so that only those druggists having a sixth-class license or a certificate of fitness should be allowed to sell

pure alcohol. We recommend this change because of the fact that the intent of the law allowing such sale to be made without a license is being violated, and unscrupulous persons have taken advantage of its provisions to establish drug stores only in name, disgracing an honorable profession, and becoming a nuisance to the community in which they are located.

The question papers, compiled for examinations during the past year, were formulated outside the regular meetings, and necessitated a great deal of extra time on the part of members of the Board. Although we have examined more candidates at each meeting, and have increased the desk room to its greatest capacity, we feel that more examinations could have been held to advantage during the year; but, owing to the extra expense incurred by members coming from a distance to the office, the Board was unable to hold these additional meetings. The Board is therefore obliged to ask for an increase of the appropriation for the members' expense account of $250. Many of the hearings which are enumerated in the secretary's report have occupied two or three hours, and have been extended well into the evening, many witnesses and the defendants with their attorneys being present.

A detailed account of the work of the Board will be found in the secretary's report, appended hereto.

Respectfully submitted,

HENRY ADAMS, *President.*
WM. F. SAWYER, *Secretary.*
FRED A. HUBBARD.
L. A. LAMSON.
CHAS. N. SWIFT.

SEPT. 30, 1906.

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*Whereas,* The retiring member of this Board, Dr. Henry Adams of Springfield, has served the State for five years with credit to himself and a benefit to the cause of pharmacy, we, the remaining members of the Board, desire to express in

this formal manner our appreciation of the valuable services of Dr. Adams, his consistent work and manly manner, showing himself as a man of worth and character.

*Therefore be it resolved,* That these resolutions be spread upon the records of this Board; also, that a copy of this resolution be sent to Dr. Adams.

WM. F. SAWYER.
FRED A. HUBBARD.
L. A. LAMSON.
CHAS. N. SWIFT.

# SECRETARY'S REPORT.

---

EXAMINATIONS.

| 1905-1906. | Days. | Examined. | Passed. | Rejected. | 1905-1906. | Days. | Examined. | Passed. | Rejected. |
|---|---|---|---|---|---|---|---|---|---|
| October 3, . | 1 | 10 | 7 | 3 | March 20, . . | 1 | 16 | 7 | 9 |
| October 10, . | 1 | 11 | 6 | 5 | March 27, . . | 1 | 14 | 5 | 9 |
| October 17, . | 1 | 10 | 6 | 4 | April 3, . . | 1 | 14 | 3 | 11 |
| October 24, . | 1 | 11 | 7 | 4 | April 17, . . | 1 | 12 | 7 | 5 |
| October 31, . | 1 | 10 | 1 | 9 | May 1, . . | 1 | 8 | 2 | 6 |
| November 6, . | 1 | 11 | 4 | 7 | May 8, . . | 1 | 10 | 2 | 8 |
| November 14, . | 1 | 31 | 14 | 17 | May 15, . . | 1 | 12 | 4 | 8 |
| November 21, . | 1 | 31 | 19 | 12 | May 22, . . | 1 | 11 | 1 | 10 |
| November 27, . | 1 | 14 | 8 | 6 | May 29, . . | 1 | 13 | 5 | 8 |
| November 28, . | 1 | 16 | 7 | 9 | June 5, . . | 1 | 12 | 2 | 10 |
| December 5, . | 1 | 9 | 0 | 9 | June 12, . . | 1 | 13 | 0 | 13 |
| January 6, . | 1 | 8 | 1 | 7 | June 15, . . | 1 | 14 | 5 | 9 |
| January 16, . | 1 | 7 | 2 | 5 | June 19, . . | 1 | 16 | 6 | 10 |
| January 30, . | 1 | 5 | 2 | 3 | June 26, . . | 1 | 15 | 10 | 5 |
| February 13, . | 1 | 9 | 5 | 4 | September 25, . | 1 | 14 | 8 | 6 |
| February 27, . | 1 | 11 | 8 | 3 | Totals, . | 32 | 410 | 166 | 244 |
| March 6, . . | 1 | 12 | 2 | 10 | | | | | |

Of the 166 certificates granted this year: —

52 passed on first examination.
39 " second "
29 " third "
18 " fourth "
13 " fifth "

8 passed on sixth examination.
5 " seventh "
1 " eighth "
1 " tenth "

Fees for examination received for the year ending Sept. 30, 1906: —

| | | |
|---|---|---|
| For first examination, 170 at $5, | $850 00 | |
| For re-examination, 229 at $3, | 687 00 | |
| For duplicate certificates, 4 at $1, | 4 00 | |
| For reciprocal exchange, 2 at $5, | 10 00 | |
| | | $1,551 00 |
| Fees returned to applicants, upon their request not to be examined, 4 at $5, | $20 00 | |
| Cash paid to State Treasurer, | 1,531 00 | |
| | | $1,551 00 |

## Applications for Certificates.

| | | |
|---|---|---|
| Applications received from Oct. 1, 1905, to March 1, 1906, to expire April 30, 1906, | | 73 |
| Certificates granted for sixth-class licenses, | 56 | |
| Certificates refused for sixth-class licenses, | 17 | |
| Applications received from March 1, 1906, to Oct. 1, 1906, to expire April 30, 1907, | | 1,578 |
| Certificates for sixth-class licenses granted, | 1,221 | |
| Certificates to sell on doctors' prescriptions granted, | 252 | |
| Certificates for sixth-class licenses refused, | 74 | |
| Certificates to sell on doctors' prescriptions refused, | 15 | |
| Applications pending action by the Board, | 16 | |
| Total number of applications for the year, | | 1,651 |
| Total number of certificates granted, | 1,529 | |
| Total number of applications refused, | 106 | |
| Total number of applications pending, | 16 | |
| Total amount of fees received during the year, | | $1,651 00 |
| Total amount paid to the State Treasurer, | $1,529 00 | |
| Total amount returned to rejected applicants, | 106 00 | |
| Cash on hand, applications pending action, | 16 00 | |

Note. — The druggists in several cities, having been granted certificates for sixth-class licenses, and having been denied licenses by the local authorities, applied for certificates from this Board to sell on doctors' prescriptions.

## Cash paid into the Treasury.

| | |
|---|---|
| Fees for examination, | $1,531 00 |
| Fees for for both classes of certificates of fitness, | 1,529 00 |
| Total amount paid to Treasurer, | $3,060 00 |

EXPENDITURES.

| | | |
|---|---|---|
| Salaries of members: — | | |
| Henry Adams, president, | $500 00 | |
| William F. Sawyer, secretary, | 1,000 00 | |
| Fred A. Hubbard, | 300 00 | |
| L. A. Lamson, | 300 00 | |
| Charles N. Swift, | 300 00 | |
| | | $2,400 00 |
| Expenses of members: — | | |
| Henry Adams, president, | $523 96 | |
| William F. Sawyer, secretary, | 263 00 | |
| Fred A. Hubbard, | 166 82 | |
| L. A. Lamson, | 352 21 | |
| Charles N. Swift, | 311 30 | |
| | | 1,617 29 |
| Agent, salary and expenses: — | | |
| Joseph E. Buswell, salary, | $1,500 00 | |
| Expenses, | 556 42 | |
| | | 2,056 42 |
| Stenographer, witness fees, incidental and contingent expenses: — | | |
| Bessie B. Burroughs, | $976 67 | |
| Wright & Potter Printing Company, | 112 89 | |
| Postal supplies, | 137 43 | |
| The E. L. Patch Company, | 50 23 | |
| Gilman Brothers, | 75 76 | |
| Whitall Tatum Company, | 69 51 | |
| New England Telephone and Telegraph Company, | 20 72 | |
| Press Clipping Bureau, | 17 70 | |
| Old Corner Book Store, | 14 86 | |
| J. L. Fairbanks & Co., | 13 35 | |
| Henry W. Stone, | 25 95 | |
| Prof. E. H. LaPierre, Massachusetts College of Pharmacy, | 26 24 | |
| Innes, Vahey & Mansfield, | 25 00 | |
| Wm. H. Bradford, | 13 00 | |
| National Association of Boards of Pharmacy, | 10 00 | |
| Dennison Manufacturing Company, | 5 30 | |
| Sampson & Murdock Company, | 6 50 | |
| Helen Pierce, | 3 50 | |
| Pocket Manual Company, | 1 00 | |
| Wm. W. Bartlett, | 1 00 | |
| E. H. Dorr & Co., | 50 | |
| Rotary Neostyle Company, | 2 25 | |
| *Amounts carried forward,* | $1,609 36 | $6,073 71 |

| | | |
|---|---|---|
| *Amounts brought forward,* | $1,609 36 | $6,073 71 |
| Stenoghrapher, witness fees, incidental and contingent expenses — *Concluded.* | | |
| Clerk of courts, Norfolk County, | 75 | |
| J. L. Hammett Company, | 6 90 | |
| Samuel Ward Company, | 1 80 | |
| Witness fees, | 6 40 | |
| | | 1,625 21 |
| | | $7,698 92 |

NOTE. — The financial year of the State ends in November, while that of the Board ends in October.

DEATHS.

| | |
|---|---|
| Auger, Leonide A., | Fall River. |
| Beedle, Charles H., | Lawrence. |
| Carpenter, Charles B., | Spencer. |
| Carpenter, Luther D., | Hudson. |
| Cherry, James B., | Boston. |
| Dickins, Charlotte L., | Newburyport. |
| Donahoe, Charles W., | Boston. |
| Holland, Henry, | Westfield. |
| Hydren, Carl, | Pittsfield. |
| Jefts, Ira P., | Boston. |
| Jellison, James M., | Boston. |
| McGarr, William L., | Malden. |
| Orne, Joel S., | Cambridge. |
| Rice, J. Allen, | Milford. |
| Sherburne, John W., | Lowell. |
| Sullivan, James J., | Springfield. |
| Titus, Walter D., | Cambridge. |
| Ware, Frank H., | Springfield. |
| Wesley, Charles M., | Boston. |

SUMMARY.

| | |
|---|---|
| Meetings: — | |
| For examination, | 32 |
| For hearings, business, etc., | 29 |
| Total number of meetings for the year, | 61 |
| Hearings: — | |
| On formal complaint, charge of aiding unregistered persons in conducting a pharmacy business, | 11 |
| On formal complaint, charge of violation of the liquor law, | 10 |
| On petitions for reinstatement as registered pharmacist after suspension by the Board, | 9 |
| With reference to applications for certificates of fitness, | 170 |
| Total number of hearings for the year, | 200 |
| Results of hearings on formal complaint: — | |
| Number of certificates suspended for five years, | 1 |
| Number of certificates suspended for three years, | 1 |
| Number of certificates suspended for two years, | 1 |
| Number of certificates suspended for one year, | 2 |
| Number of certificates suspended for six months, | 4 |
| Number of cases placed on file, | 10 |
| Number of cases continued, | 2 |

Miscellaneous: —

| | |
|---|---|
| Number of suspended pharmacists who were reinstated, | 9 |
| Number of persons against whom formal complaints are pending, | 10 |
| Amount of fines paid by druggists for violation of laws relating to pharmacy, | $1,900 |
| Number imprisoned, | 2 |
| New drug stores opened during the year, | 93 |
| Number of drug stores closed through prosecution, | 19 |
| Number of drug stores closed by reason of death, failure, etc., | 26 |
| Number of drug stores in the State at the present time, | 1,563 |

WM. F. SAWYER,
*Secretary.*

# LAWS

RELATING TO

# THE PRACTICE OF PHARMACY

IN

# MASSACHUSETTS.

1906.

# LAWS RELATING TO PHARMACY.

**Chapter 76, Revised Laws.**

## Registration of Pharmacists.

Section 10. There shall be a board of registration in pharmacy consisting of five persons, residents of the commonwealth, who shall be skilled pharmacists, and shall have had ten consecutive years of practical experience in the compounding and dispensing of physician's prescriptions, and shall be actually engaged in the drug business. Not more than one member shall have any financial interest in the sale of drugs, medicines and chemicals, and the compounding and dispensing of physician's prescriptions in the same councillor district. One member of said board shall annually in September be appointed by the governor, with the advice and consent of the council, for a term of five years from the first day of October following, and no person appointed after the twenty-fifth day of June in the year eighteen hundred and ninety-nine shall serve as a member of said board for more than five consecutive years.

Section 11. Said board shall meet on the first Tuesday of October in each year at such time and place as it may determine, and shall organize by electing a president and secretary, who shall be members of the board and who shall hold their offices for the term of one year. The secretary shall give to the treasurer and receiver general a bond with sufficient sureties, to be approved by the governor and council, for the faithful performance of his official duties. The board shall annually hold regular meetings on the first Tuesday of January, May and October, and additional meetings at such times and places as it shall determine.

Section 12. Each member of the board shall receive five dollars for every day actually spent in the performance of his duties and the amount actually paid by him, not exceeding three cents a mile each way, for necessary travelling expenses in attending the meetings of the board. The bills for such compensation and his incidental and travelling expenses shall be approved by the board and paid by the commonwealth. So much of the

receipts from examinations as may be necessary for the compensation and expenses of the board may, in addition to any amount authorized by the general court, be used for such purpose.

SECTION 13. The board shall keep a record of the names of all persons examined and registered hereunder and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor and council of the condition of pharmacy in the commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

SECTION 14. A person who desires to do business as a pharmacist shall, upon payment of five dollars, be entitled to examination, and if found qualified shall be registered as a pharmacist and shall receive a certificate signed by the president and secretary of said board. Any person who fails to pass such examination shall upon request be re-examined after the expiration of three months at any regular meeting of the board, upon the payment of three dollars. All fees received by the board shall be paid by its secretary into the treasury of the commonwealth.

SECTION 15. Every person who has received a certificate of registration from the board shall conspicuously display the same in his place of business.

SECTION 16. The board shall hear all applications by registered pharmacists for the granting of sixth class licenses, if a hearing is requested by the applicant, and all complaints made to them against any person registered as a pharmacist charging him in his business as a pharmacist with violating any of the laws of the commonwealth, the enforcement of which is under the supervision of the board of registration in pharmacy, and especially of the laws relating to the sale of intoxicating liquor; or engaging with, or aiding or abetting, another in the violation of said laws; or, if he himself is not the owner and actively engaged in such business, with suffering or permitting the use of his name or certificate of registration by others in the conduct of the business of pharmacy. Such complaint shall set out the offence alleged and be made within fifteen days after the date of the act complained of. The board shall notify the person complained against of the charge against him and of the time and place of the hearing at which he may appear with his witnesses and be heard by counsel. Three of the members of the board shall be a quorum for such hearing. Witnesses at hearings before such board shall testify under oath and may be sworn by a member of the board. The board shall have power to send for persons and compel the attendance of witnesses at said hearings.

SECTION 17. If the full board sitting at such hearing finds the person guilty, the board may suspend the effect of the certificate of his registration as a pharmacist for such term as the board fixes, but the license or certificate of registration of a registered pharmacist shall not be suspended for a cause punishable by law until after his conviction by a court of competent jurisdiction.

SECTION 18. Whoever, not being registered as aforesaid, retails, compounds for sale or dispenses for medicinal purposes or keeps or exposes for sale drugs, medicines, chemicals or poisons, except as provided in section twenty-three, shall be punished by a fine of not more than fifty dollars. But the provisions of this section shall not prohibit the employment of apprentices or assistants under the personal supervision of a registered pharmacist.

SECTION 19. The board shall investigate all complaints of the violation of the provisions of sections ten to twenty-three, inclusive, and report the same to the proper prosecuting officers, and especially investigate and cause to be prosecuted all violations of sections twenty-one to twenty-nine, inclusive, of chapter one hundred.

SECTION 20. The board of registration in pharmacy may annually expend not more than two thousand dollars in the performance of its official duties.

SECTION 21. A registered pharmacist against whom a complaint or charge is pending before the board, or his counsel, shall have the same right of access to documents in the possession of said board as a person who is charged with crime in the courts of the commonwealth would have to documents in the possession of the clerk of the court or of the prosecuting officer.

SECTION 22. The court or magistrate before whom a person is convicted of a violation of section twenty-six of chapter seventy-five, of section eighteen of this chapter, of sections twenty-five, twenty-six, twenty-seven of chapter one hundred or of section two of chapter two hundred and thirteen shall send to the board of registration in pharmacy a certificate under seal showing the time, cause and place of conviction.

SECTION 23. The provisions of sections twenty-one to twenty-nine, inclusive, of chapter one hundred, section twenty-six of chapter seventy-five and section two of chapter two hundred and thirteen shall not apply to physicians who put up their own prescriptions or dispense medicines to their patients; nor to the sale of drugs, medicines, chemicals or poisons at wholesale only; nor to the manufacture or sale of patent and proprietary medicines; nor to the sale of non-poisonous domestic remedies usually sold by grocers and others; nor shall any unregistered member of a

copartnership be liable to the penalties hereof if he retails, compounds for sale or dispenses for medicinal purposes drugs, medicines, chemicals or poisons only under the personal supervision of a registered pharmacist. The widow, executor or administrator of a registered pharmacist who has died or the wife of one who has become incapacitated may continue his business under a registered pharmacist.

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### Chapter 120, Acts of 1906.

### An Act relative to Registration in Pharmacy.

*Be it enacted, etc., as follows:*

Section fourteen of chapter seventy-six of the Revised Laws is hereby amended by inserting after the word "dollars", in the seventh line, the words: — The said board may, in its discretion, grant certificates of registration to such persons as shall furnish with their application satisfactory proof that they have been registered by examination in some other state: *provided,* that such other state shall require a degree of competency equal to that required of applicants in this state. Every applicant for registration as a registered pharmacist shall pay to the secretary of the board the sum of five dollars at the time of filing the application, — so as to read as follows: — *Section 14.* A person who desires to do business as a pharmacist shall, upon payment of five dollars, be entitled to examination, and if found qualified shall be registered as a pharmacist and shall receive a certificate signed by the president and secretary of said board. Any person who fails to pass such examination shall upon request be re-examined after the expiration of three months at any regular meeting of the board, upon the payment of three dollars. The said board may, in its discretion, grant certificates of registration to such persons as shall furnish with their application satisfactory proof that they have been registered by examination in some other state: *provided,* that such other state shall require a degree of competency equal to that required of applicants in this state. Every applicant for registration as a registered pharmacist shall pay to the secretary of the board the sum of five dollars at the time of filing the application. All fees received by the board shall be paid by its secretary into the treasury of the Commonwealth. *Approved March 1, 1906.*

CHAPTER 100, REVISED LAWS.

INTOXICATING LIQUORS, — DRUGGISTS AND APOTHECARIES.

SECTION 21. Druggists and apothecaries may sell pure alcohol for medicinal, mechanical or chemical purposes; and wholesale druggists and apothecaries may also sell liquor of any kind, not to be drunk on the premises, under a license of the fourth class.

SECTION 22. No license for the sale of spirituous or intoxicating liquor, except of the sixth class, shall be granted to retail druggists or apothecaries. One or more licenses of the sixth class shall be granted annually by the licensing board of cities, or by the mayor and aldermen of cities having no such board, or by the selectmen of towns, to retail druggists or apothecaries who are registered pharmacists actively engaged in business on their own account, upon presentation to the licensing board of the certificate of fitness prescribed by the following section, if it appears that the applicant is a proper person to receive such license, and is not disqualified to receive it under the provisions of sections fifty-three and fifty-four. A registered pharmacist who owns stock of the actual value of at least five hundred dollars in a corporation which has been incorporated for the purpose of carrying on the drug business, and who conducts in person the business of a store of such corporation, shall be considered as actively engaged in business on his own account and as qualified to receive a license for such store.

SECTION 23. The board of registration in pharmacy may, upon the payment by an applicant for a license of the sixth class of a fee of not more than one dollar, issue to him a certificate, which shall not be valid after one year from its date, stating that in the judgment of said board he is a proper person to be entrusted with such license and that the public good will be promoted by the granting thereof. Any registered pharmacist against whom no complaints have been made to said board may be considered a proper person to receive such certificate. If complaint is made, it shall state in writing the reason why a certificate should be withheld.

SECTION 24. A license of the sixth class shall become null and void without any process or decree, if the registered pharmacist to whom it has been granted ceases to conduct his business in person and on his own account, or upon the revocation of his certificate of registration as a pharmacist, unless the registered pharmacist has become unable to so conduct his business or has died, and his business is continued by his wife, widow, executor or administrator under another registered pharmacist.

SECTION 25. Retail druggists and apothecaries shall not sell intoxicating liquor of any kind for medicinal, mechanical or

chemical purposes except upon the certificate of the purchaser, which shall state the use for which it is wanted, and which shall be immediately cancelled at the time of sale in such manner as to show the date of cancellation. They shall not, when making such sales upon the prescription of a physician, be subject to the provisions of the second clause of section seventeen.

SECTION 26. Every retail druggist and apothecary shall keep a book in which he shall enter, at the time of every such sale, the date thereof, the name of the purchaser, the kind, quantity and price of said liquor, the purpose for which it was sold, and the residence by street and number, if there be such, of said purchaser. If such sale is made upon the prescription of a physician, the book shall also contain the name of the physician and shall state the use for which said liquor is prescribed and the quantity to be used for such purpose, and shall be cancelled in the manner before provided with reference to certificates. Said book shall be in form substantially as follows:—

| Date. | Name of Purchaser. | Residence. | Kind and Quantity. | Purpose of Use. | Price. | Name of Physician. |
|---|---|---|---|---|---|---|

The certificate mentioned in the preceding section shall be a part of said book, and shall not be detached therefrom, and shall be in form substantially as follows:—

*Certificate.*

I wish to purchase........................................
and I certify that I am not a minor and that the same is to be used for * Mechanical * Chemical * Medicinal purposes. [* Draw a line through the words which do not indicate the purpose of the purchase.]

Signature ............................

Cancelled ............................

SECTION 27. The book, certificates and prescriptions provided for in the two preceding sections and the book provided for in section thirty-two shall at all times be open to the inspection of the licensing board in cities having such boards and in all other cities and towns, to the inspection of the mayor and aldermen, selectmen, overseers of the poor, sheriffs, constables, police officers and justices of the peace.

SECTION 28. Whoever makes or issues a false or fraudulent certificate or prescription referred to in sections twenty-five and twenty-six shall be punished by a fine of ten dollars.

SECTION 29. Whoever, not being a registered pharmacist, procures a sixth class license for the sale of intoxicating liquors in the name of a registered pharmacist who is dead, or in the name of a registered pharmacist by borrowing, hiring or purchasing the use of his certificate, and who, being himself the owner or manager of the place, shall himself or by his servants sell intoxicating liquor, shall be punished by a fine of not less than fifty nor more than five hundred dollars, and by imprisonment for not less than one nor more than six months. The provisions of section ten of chapter two hundred and twenty shall not apply to such sentence.

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### CHAPTER 281, ACTS OF 1906.

## AN ACT RELATIVE TO THE SALE OF INTOXICATING LIQUORS BY REGISTERED PHARMACISTS.

*Be it enacted, etc., as follows:*

SECTION 1. In any city or town in which licenses for the sale of intoxicating liquors of the first five classes are not granted, registered pharmacists to whom a certificate of fitness has been issued as provided for by section two of this act, may sell intoxicating liquors upon the prescription of a registered physician practising in such city or town, provided that the prescription is dated, contains the name of the person prescribed for, and is signed by the physician. All such prescriptions shall be retained and kept on file in a separate book by the pharmacist filling the same, and shall not be filled a second time. Such prescription book shall be open at all times to the inspection provided for in section twenty-seven of chapter one hundred of the Revised Laws.

SECTION 2. The board of registration in pharmacy may, upon the payment by each applicant of a fee of not more than one dollar, issue to registered pharmacists certificates of fitness as provided for in section twenty-three of said chapter one hundred. Such certificates of fitness shall be subject to suspension or revocation by the board of registration in pharmacy, or by the licensing authorities of such cities and towns.

SECTION 3. Whoever violates any provision of this act shall be punished by a fine of not less than fifty nor more than five hundred dollars, or by imprisonment for not less than one month nor more than six months, or by both such fine and imprisonment.

SECTION 4. All acts and parts of acts inconsistent herewith are hereby repealed. *Approved April 14, 1906.*

CHAPTER 100, REVISED LAWS.

### GRANTING OF LICENSES BY LOCAL BOARD.

SECTION 16. The licensing board may at any time refuse to issue a license to a person whom it considers unfit to receive the same; but the provisions of this chapter shall not be so construed as to compel said licensing board to grant licenses.

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CHAPTER 100, REVISED LAWS.

### CONDITIONS OF LICENSES.

SECTION 17. Each license shall be expressed, to be subject to the following conditions: —

First, That the provisions in regard to the nature of the license, and the building in which the business may be carried on under it, shall be strictly adhered to.

Second, That spirituous or intoxicating liquor shall not be sold between the hours of eleven at night and six in the morning or on the Lord's day; but if the licensee is also licensed as an innholder he may, between the hours of six in the morning and eleven at night on the Lord's day, supply such liquors to guests who have resorted to his inn for food and lodging.

Third, That spirituous or intoxicating liquor shall not be sold, exchanged or delivered, or exposed, offered or kept for sale, exchange or delivery, upon the licensed premises, unless it is of good standard quality and is free from any adulteration prohibited in the Pharmacopœia of the United States or by the laws relative to adulteration of drugs and food, for either a food or a drug. If it is marked, labelled or represented as being the product of any foreign country, it shall also be of the standard quality required for its legal sale for domestic use in the country of its reputed production. All such liquors which are sold, exchanged or delivered, or which are exposed or kept for sale, exchange or delivery, under a license of the sixth class, shall be of the quality required for their sale as drugs under the provisions of the laws relative to the adulteration of drugs and food.

Fourth, That liquor shall not be sold or delivered on the licensed premises to a person who is known to be a drunkard, to an intoxicated person, or to a person who is known to have been intoxicated within the six months last preceding, or to a minor, either for his own use, the use of his parents or of any other person, or, unless upon the prescription of a duly registered physician, to a person known to have been supported in whole or in part by public charity at any time during the twelve months last preceding the date of the license.

CHAPTER 100, REVISED LAWS.

### FORFEITURE OF LICENSE.

SECTION 47. The licensing board, after notice to the licensee and reasonable opportunity for him to be heard by them or by a committee of the mayor and aldermen or selectmen, if the license was granted by them, may declare his license forfeited, upon satisfactory proof that he has violated or permitted a violation of any condition thereof. The pendency of proceedings before a court of justice shall not suspend or interfere with the power herein given to decree a forfeiture. If the license is declared to have been forfeited, the licensee shall be disqualified to receive a license for one year after the expiration of the term of the license so forfeited, and if he is the owner of the premises described in such forfeited license, no license shall be issued to be exercised on said premises for the residue of the term thereof.

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CHAPTER 100, REVISED LAWS.

### TRANSFER OF LICENSES.

SECTION 44. Licensing boards may transfer licenses from one location to another within the city or town in which such licenses are in force; but such transfer shall be granted only to the original licensee, and like notice shall be given, the same provisions shall apply, and other proceedings shall be the same as are required upon the granting of licenses, except that no new license fee shall be required.

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CHAPTER 321, ACTS OF 1902.

### AN ACT TO AUTHORIZE THE BOARD OF REGISTRATION IN PHARMACY TO RECONSIDER ITS ACTION IN CASES WHERE IT MAY HAVE SUSPENDED OR REVOKED THE LICENSE OR CERTIFICATE OF REGISTRATION.

*Be it enacted, etc., as follows:*

SECTION 1. Section seventeen of chapter seventy-six of the Revised Laws is hereby amended by inserting after the word "suspended", in the fifth line, the words: — or revoked, — and by adding at the end thereof the words: — The board may at any time in its discretion reconsider its action in cases where it has suspended or revoked the license or certificate of registration of a pharmacist, and may change its determination as jus-

tice shall require, — so as to read as follows: — *Section 17.* If the full board sitting at such hearing finds the person guilty, the board may suspend the effect of the certificate of his registration as a pharmacist for such term as the board fixes, but the license or certificate of registration of a registered pharmacist shall not be suspended or revoked for a cause punishable by law until after his conviction by a court of competent jurisdiction. The board may at any time in its discretion reconsider its action in cases where it has suspended or revoked the license or certificate of registration of a pharmacist, and may change its determination as justice shall require.

SECTION 2. This act shall take effect upon its passage.

*Approved April 18, 1902.*

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**CHAPTER 327, ACTS OF 1902.**

AN ACT RELATIVE TO CONDUCTING THE BUSINESS OF A DECEASED PHARMACIST BY HIS WIDOW, EXECUTOR OR ADMINISTRATOR.

*Be it enacted, etc., as follows:*

SECTION 1. Section twenty-three of chapter seventy-six of the Revised Laws is hereby amended by adding at the end thereof the words: — who may also be considered qualified to receive a sixth class license to be exercised upon said premises of said deceased or incapacitated pharmacist under the registered licensee's personal supervision. The provisions of section twenty-two of chapter one hundred, so far as they may be inconsistent herewith, shall not apply to licenses issued hereunder, — so as to read as follows: — *Section 23.* The provisions of sections twenty-one to twenty-nine, inclusive, of chapter one hundred, section twenty-six of chapter seventy-five and section two of chapter two hundred and thirteen shall not apply to physicians who put up their own prescriptions or dispense medicines to their patients; nor to the sale of drugs, medicines, chemicals or poisons at wholesale only; nor to the manufacture or sale of patent and proprietary medicines; nor to the sale of non-poisonous domestic remedies usually sold by grocers and others; nor shall any unregistered member of a copartnership be liable to the penalties hereof if he retails, compounds for sale or dispenses for medicinal purposes drugs, medicines, chemicals or poisons only under the personal supervision of a registered pharmacist. The widow, executor or administrator of a registered pharmacist who has died or the wife of one who has become incapacitated may continue his business under a registered pharmacist, who

may also be considered qualified to receive a sixth class license to be exercised upon said premises of said deceased or incapacitated pharmacist under the registered licensee's personal supervision. The provisions of section twenty-two of chapter one hundred, so far as they may be inconsistent herewith, shall not apply to licenses issued hereunder.

SECTION 2. This act shall take effect upon its passage.

*Approved April 18, 1902.*

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**CHAPTER 505, ACTS OF 1902.**

AN ACT TO ESTABLISH THE SALARIES OF THE MEMBERS OF THE BOARD OF REGISTRATION IN MEDICINE, THE BOARD OF REGISTRATION IN PHARMACY AND THE BOARD OF REGISTRATION IN DENTISTRY.

*Be it enacted, etc., as follows:*

SECTION 2. The secretary of the board of registration in pharmacy shall receive a salary of one thousand dollars a year, and the other members of said board shall each receive a salary of three hundred dollars a year, except that the chairman of said board shall receive a salary of five hundred dollars.

SECTION 4. Each member of the boards mentioned in sections one, two and three shall receive in addition to his salary his necessary travelling expenses actually incurred in attending the meetings of the board. The salaries and expenses of the members of the board of registration in medicine, the board of registration in pharmacy and the board of registration in dentistry shall be paid out of the treasury of the Commonwealth.

SECTION 5. The fees received for examination and registration of applicants before the board of registration in medicine, before the board of registration in pharmacy, and before the board of registration in dentistry, shall be paid monthly by the secretaries of the respective boards into the treasury of the Commonwealth.

SECTION 6. Sections four, twelve and twenty-seven of chapter seventy-six of the Revised Laws are hereby repealed.

SECTION 7. This act shall take effect on the first day of July in the year nineteen hundred and two.

*Approved June 23, 1902.*

**Chapter 23, Acts of 1906.**

### An Act making Appropriations for the Board of Registration in Pharmacy.

*Be it enacted, etc., as follows:*

Section 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the Commonwealth from the ordinary revenue, for the purposes specified, for the eleven months ending on the thirtieth day of November, nineteen hundred and six, to wit: —

For the salaries of the members of the board of registration in pharmacy, twenty-two hundred dollars.

For travelling and other expenses of the members of the board, a sum not exceeding thirteen hundred fifty-two dollars and eight cents.

For the salary and expenses of the agent of the board, a sum not exceeding twenty-two hundred dollars.

For a stenographer, witness fees and incidental and contingent expenses of the board, the same to include the printing of the annual report, a sum not exceeding thirteen hundred and seventy-five dollars.

Section 2. This act shall take effect upon its passage.

*Approved January 24, 1906.*

The following laws come under the jurisdiction of the State Board of Health: —

**Chapter 213, Revised Laws.**

### Of Crimes against the Public Health.

Section 2. Whoever sells arsenic (arsenious acid), atropia or any of its salts, chloral hydrate, chloroform, cotton root and its fluid extract, corrosive sublimate, cyanide of potassium, Donovan's solution, ergot and its fluid extract, Fowler's solution, laudanum, McMunn's elixir, morphia or any of its salts, oil of pennyroyal, oil of savin, oil of tansy, opium, Paris green, Parsons' vermin exterminator, phosphorus, prussic acid, "rough on rats", strychnia or any of its salts, tartar emetic, tincture of aconite, tincture of belladonna, tincture of digitalis, tincture of nux vomica, tincture of veratrum, viride, or carbolic acid, without the written prescription of a physician, shall affix to the bottle, box or wrapper containing the article sold a label of red paper upon which shall be printed in large black letters the name and place of business of the vendor and the words *Poison* and *Antidote*, and the label shall also contain the name of an antidote, if any, for the poison sold. He shall also keep a record of the name

and quantity of the article sold and of the name and residence of the person or persons to whom it was delivered, which shall be made before the article is delivered and shall at all times be open to inspection by the officers of the district police and by the police authorities and officers of cities and towns; but no sale of cocaine or its salts shall be made except upon the prescription of a physician. Whoever neglects to affix such label to such bottle, box or wrapper before delivery thereof to the purchaser or whoever neglects to keep or refuses to show to said officers such record or whoever purchases any of said poisons and gives a false or fictitious name to the vendor shall be punished by a fine of not more than fifty dollars. The provisions of this section shall not apply to sales by wholesale dealers or manufacturing chemists to retail dealers, or to a general merchant who sells Paris green, London purple or other arsenical poisons in unbroken packages containing not less than one-quarter of a pound, for the sole purpose of destroying potato bugs or other insects upon plants, vines or trees, except that he shall record each sale and label each package sold, as above provided.

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### Chapter 220, Acts of 1905.

### An Act relative to Wood Alcohol.

*Be it enacted, etc., as follows:*

Section 1. Whoever, himself or by his servant or agent, or as the servant or agent of any other person, sells, exchanges or delivers any wood alcohol, otherwise known as methyl alcohol, shall affix to the vessel containing the same and shall deliver therewith a label bearing the words "Wood Alcohol, Poison", in black letters of uncondensed Gothic type not less than one-fourth of an inch in height. Whoever violates the provisions of this section shall pay a fine of not less than fifty dollars nor more than two hundred dollars.

Section 2. Whoever, himself or by his servant or agent, or as the servant or agent of any other person, sells, exchanges or delivers, or has in his possession with intent to sell, exchange or deliver, any article of food or drink, or any drug intended for internal use, containing any wood alcohol, otherwise known as methyl alcohol, shall be punished by a fine of not less than two hundred dollars or by imprisonment for not more than thirty days, or by both such fine and imprisonment.

*Approved March 27, 1905.*

CHAPTER 386, ACTS OF 1906.

AN ACT RELATIVE TO THE LABELLING OF CERTAIN PATENT OR PROPRIETARY DRUGS AND FOODS.

*Be it enacted, etc., as follows:*

SECTION 1. Upon every package, bottle or other receptacle holding any proprietary or patent medicine, or any proprietary or patent food preparation, which contains alcohol to an amount in excess of the amount shown to be necessary by the United States Pharmacopœia or the National Formulary as a solvent or preservative of the active constituents of the drugs contained therein, shall be marked or inscribed a statement of the percentage of alcohol by volume contained therein; and the provisions of section nineteen of chapter seventy-five of the Revised Laws shall apply to the manner and form in which such statements shall be marked or inscribed.

SECTION 2. Every package, bottle or other receptacle holding any proprietary or patent medicine or any proprietary or patent food preparation shall bear a label containing a statement of the quantity of any opium, morphine, heroin or chloral-hydrate contained therein, provided that the package contains more than two grains of opium, or more than one fourth grain of morphine, or more than one sixteenth grain of heroin, or more than eight grains of chloral-hydrate in one fluid ounce, or, if a solid preparation, in one avoirdupois ounce; and the provisions of section nineteen of chapter seventy-five of the Revised Laws shall apply to the manner and form in which such statements shall be marked or inscribed.

SECTION 3. It shall be unlawful for any person to sell, or to expose or offer for sale, or to give or exchange, any patent or proprietary medicine or article containing cocaine or any of its salts, or alpha or beta eucaine or any synthetic substitute of the aforesaid.

SECTION 4. It shall be unlawful for any person to sell, or to expose or offer for sale, or to give or exchange any cocaine or alpha or beta eucaine or any synthetic substitute of the aforesaid, or any preparation containing the same, or any salts or compounds thereof, except upon the written prescription of a physician, dentist or veterinary surgeon registered under the laws of the Commonwealth; the original of which prescription shall be retained by the druggist filling the same and shall not again be filled.

SECTION 5. The provisions of sections three and four shall not apply to sales at wholesale made to retail druggists or dental depots nor to sales made to physicians, dentists or regularly incorporated hospitals.

SECTION 6. Whoever manufactures, sells or offers for sale any medicine or food preparation in violation of the provisions of this act shall be punished by a fine of not less than five nor more than one hundred dollars. It shall be the duty of the state board of health to cause the prosecution of all persons violating the provisions of this act; but no prosecution shall be brought for the sale at retail, or for the gift or exchange of any patent or proprietary medicine or food preparation containing any drug or preparation the sale of which is prohibited or restricted as aforesaid, unless the said board has, prior to such sale, gift or exchange, given public notice in such trade journals or newspapers as it may select that the gift, exchange or sale at retail of the said medicine or food preparation would be contrary to law.

SECTION 7. This act shall take effect on the first day of September in the year nineteen hundred and six.

*Approved May 11, 1906.*

WACHUSETT DAM WITH RAILROAD ARCH BRIDGE, WASTE WEIR AND BASTION AT NORTHWESTERLY END.

PUBLIC DOCUMENT . . . . . . . . No. 57.

# SIXTH ANNUAL REPORT

OF THE

# METROPOLITAN WATER AND SEWERAGE BOARD.

JANUARY 1, 1907.

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## LIST OF ILLUSTRATIONS.

# METROPOLITAN WATER AND SEWERAGE BOARD.

*To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.*

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the calendar year ending December 31, 1906, and now presents a detailed statement of the operations for the year, being its

## SIXTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

## I. ORGANIZATION AND ADMINISTRATION.

### (1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of Henry H. Sprague expired on March 21, 1906, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and paymaster.

There are also employed in the administrative office a book-keeper, an assistant book-keeper, an assistant in auditing, one general clerk, three stenographers, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow has been in charge of the conveyancing work, and he has been assisted by Miss Alline E. Marcy, title examiner. Miss Celia M. Tibbetts has performed the conveyancing work which has been required in the county of Worcester as her services have been needed.

Frederic P. Stearns has continued to hold the position of Chief Engineer of the Board, with special oversight of the Water Works, but, inasmuch as Mr. Stearns was able to give only a part of his services to the Board, much of the work of active supervision has devolved upon Dexter Brackett, the Engineer of the Sudbury and Distribution departments. Thomas F. Richardson remained as Engineer of the Dam and Reservoir Department until July 20, when he resigned, and the supervision of this department also was given to Mr. Brackett.

Joseph P. Davis and Hiram F. Mills are retained to act as consulting engineers if matters arise requiring their consideration.

A reduction has again been made in the engineering force employed in construction on the Water Works, but, on the other hand, a considerable addition has been required in the number employed upon the maintenance and operation of works. The force, both in construction and maintenance, has, upon the average during the year, comprised, in addition to the persons above named, 5 division engineers, 7 assistant engineers, and others, to the number of 41, in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, numbering in all, 53. The maximum engineering force employed at any one time during the year on both construction and maintenance was 61.

Day-labor forces, under the general supervision of the engineers and the immediate direction of foremen, varying in numbers from time to time, have been employed in pipe laying, in general improvements and repairs, and in minor operations.

A further maintenance force, numbering, upon the average during the year, 217, has been required at the pumping stations and upon the reservoirs, aqueducts, pipe lines and other works. This force at the end of the year numbered 214.

William M. Brown, Engineer of the Sewerage Works, has been in charge of both construction and maintenance upon these works.

He was assisted during the year by 3 division engineers, in supervision of both construction and maintenance, 1 division engineer in direct charge of the drafting room and records, 5 assistant engineers, and 12 others, who were employed in various engineering capacities, and a clerk and stenographer. The maximum engineering force em-

ployed at any one time during the year on construction and maintenance of the Sewerage Works was 23.

Day-labor forces, under the general supervision of the engineers and the immediate direction of foremen, have been employed in the construction of the pneumatic tunnel on Section 80 of the High-level Sewer extension in West Roxbury, in the placing of sidewalks and fences at the Ward Street pumping station, in the building of foundations for additional boilers and engine plant at the Quincy pumping station, and the building of a bellmouth connection between the existing Metropolitan Sewer and Section 64 of the Malden sewer extension.

The maximum number of men employed upon contracts and upon day-labor construction upon the Sewerage Works during the year was for the week ending December 22, when the number amounted to 154.

The regular maintenance force required for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of engineers and day-labor construction forces before enumerated, has upon the average numbered 130.

The whole force of the Sewerage Department at the end of the year numbered 156, of whom the engineer in charge and 21 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 79 were employed upon the North System and 55 upon the South System.

### (2) Offices and Buildings.

The office of the Metropolitan Water and Sewerage Board is in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in which are also located the secretary's, auditing and conveyancing offices, and the main engineering offices of both the Water Works and the Sewerage Works.

The headquarters of the Wachusett Dam and Reservoir Department of the Water Works have been maintained in the office building in Clinton. Headquarters of the Sudbury and Distribution departments have been maintained in the central office in Boston. For the Sudbury Department a branch office has been maintained at South Framingham. Branch headquarters of the maintenance force of the Water Works in the northern part of the District have been

in buildings in the Glenwood pipe yard in Medford, where there are offices, shops, store rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained at the East Boston and Ward Street pumping stations and at the storage yard at Hough's Neck.

### (3) Conveyancing.

Much of the work of the conveyancer has been the revision and bringing up to date of titles, which had been previously examined, when settlement regarding the estates affected had been finally attained, or when the suits involving them had been reached in court proceedings.

The acquisition of lands about Lake Waushacum, for the Water Works, required an extensive examination of new titles, and like examinations have been required on account of the extensions of the North and South Metropolitan Sewerage systems. Not so extensive, though considerable, examinations of titles have been required in the settlement of the many claims for damage to estates arising from the flooding of the Germantown district in Clinton, by reason of the discontinuance of South Main Street in Clinton, from the widening of Crescent Street in West Boylston, and for depreciation in value of estates in West Boylston and Sterling, as well as for the preparation of the suits brought for the alleged depreciation in value of estates in Boylston and damages to meadow lands in Clinton, Lancaster and Bolton by reason of the cessation of floods.

The conclusion of settlements has called for the drafting of many releases and other instruments.

The conveyancer has prepared eleven takings, covering or affecting 29 parcels of land aggregating 203.876 acres, as well as many public streets, and he has, from time to time, made various investigations relative to lands and easements required in matters coming before the Board.

The conveyancing force has also been called upon at several times by the Attorney-General to perform work not relating to this department.

## II. METROPOLITAN WATER DISTRICT.

There are now 19 municipalities constituting the Metropolitan Water District, the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Watertown and Winthrop. Of these, the city of Quincy and the towns of Arlington, Lexington, Milton, Nahant and Stoneham have, since the formation of the District by the Act of the year 1895, been admitted into the District in accordance with the provision that the Board shall, on application, admit any other city or town than those originally named, any part of which is within ten miles of the State House, on such payment of money as the Board may determine. The District has an area of 171.7 square miles. The population of the District as now comprised, as of July 1, 1906, the date upon which calculations for the Water Works are based, is estimated at 960,460.

The city of Newton and the town of Hyde Park, though belonging to the District, do not take water from the Metropolitan sources, but still depend upon their own sources of supply.

No city or town has been admitted to the District within the past year.

## III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for construction, including real estate acquired and payment of claims on account of the Water Works, during the year 1906, was $1,234,662.79. Of this amount, $186,261.57 was expended on account of the Wachusett Dam and Reservoir; $4,208.21 on account of the Weston Aqueduct and Reservoir; $101,996.14 for the improvement of the Wachusett watershed; $899,259.23 for the acquisition of existing water works, including $896,659.23 paid the cities of Malden, Medford and Melrose; $24,541.17 for construction in the Distribution Department; and the remainder, $18,396.47, for various other operations on the works. The total amount expended on account of construction since the beginning of the Water Works in the year 1895 has been $40,278,877.02.

## (1) Wachusett Dam and Reservoir.

### (a) *Wachusett Dam.*

But little work remained to be accomplished at the beginning of the year in order to secure the substantial completion of the Wachusett Dam.

The McArthur Brothers Company, the contractor for building the dam, completed its contract by the excavation of about 1,400 cubic yards of earth and 1,900 cubic yards of rock on the waste channel. A final settlement with the contractor has not, however, yet been effected.

The granolithic surface on the top of the dam and of the abutment at the southeasterly end and the bastion at the northwesterly end, as well as the granolithic walk from the abutment to Boylston Street, was laid during the early summer, and a heavy fence of brass posts and rails was erected on each side of the top of the dam, between the terminal structures, for general protection.

The entrance to the dam from Boylston Street has been completed by the laying of a granolithic walk from the street to the abutment, the erection of steel gates between the massive granite posts at the end of the main dam at its junction with the abutment, and by the building of steel fences, gravel walks and granite curbing on both sides of the entrance and for a considerable distance along the street.

An iron fence has also been built from the bastion on the retaining wall to the railroad bridge.

Permanent pipe connection with a Venturi meter has also been made with the pipe line supplying water to the Lancaster Mills.

The road from the bastion along the northwesterly hillside to the grounds below the dam has been completed, and the hillside has been graded and improved by the removal and use of the large pile of loam which had been stored near the end of the dam, and has also been planted in places with shrubbery.

A lighting and pumping plant for use at the dam has been acquired, and is about ready to be installed in the lower gate-chamber or power-house. The turbine will be operated by water power, and the generator with which it is connected will furnish a current for lighting and for the operation of motors which will be used for various necessary purposes connected with the works in both the gate-chambers.

WACHUSETT DAM WITH POWER AND GATE HOUSE, POOL AND SPILLWAY.

The structure of the dam itself has now been completed. The construction of the dam has required the excavation of 274,087 cubic yards of earth and of 102,640 cubic yards of rock, the placing of 251,920 cubic yards of rubble-stone masonry and a total of 22,519 cubic yards of dimension stone, ashlar, brick and concrete masonry, and there have also been used in the work 81,940 barrels of Portland cement and 182,480 barrels of natural cement.

The maximum height of the dam, from the lowest point to which excavation was made and masonry laid, to the top of the cornice stones, is 228.2 feet. The maximum width or thickness of the dam is 185 feet, and this width decreases to 25.04 feet at the high-water line. At the top of the dam, which is 20 feet above the high-water line, the width is 25.75 feet.

The length of the main dam is 944 feet, and the length of the waste weir beyond the bastion at the northwesterly end, over which the water may overflow, is 452 feet. The total length of the dam, including the corewall, is 1,476 feet.

The preliminary work for determining the proper site was begun on August 7, 1895. Temporary and preliminary work in connection with the construction of the dam began on June 14, 1897. The main contract for the dam was made on October 1, 1900, and was finished on February 27, 1906. Something remains for final settlement, but the sum so far expended upon the construction of the dam has been $2,270,116.85.

### (b) *Wachusett Reservoir.*

The soil had substantially all been stripped from the bed of the reservoir prior to the past year. There were, however, on both sides of the reservoir steep banks which had been worn away by the frosts and waves, so that they had retreated nearly to the limit of the original soil stripping. Considerable work, therefore, has been done by day labor in clearing, grubbing and removal of soil, in order to increase the area subject to overflow. Some material has also been removed from the bed of the reservoir, in order to fill the gap in the South Dike through which had passed the quarry railroad used in the construction of the dam. In other cases, on both sides of the reservoir near the dam, where the ground is sloping in the vicinity of the flow line, the shores have been protected by cobblestones.

The work of obtaining the elevations of the bottom of the reservoir after excavation has been completed. The succeeding calculations necessary to determine the capacity of the reservoir at successive elevations of one-tenth of a foot have been nearly completed.

A few further buildings have been removed from the reservoir site during the year, and the work of such removal upon the site of the reservoir has been completed. The total number of buildings removed in West Boylston under the operations of the Board to the present time has been 350. There have also been removed from the site of the reservoir, 108 buildings in Boylston, 7 in Sterling and 45 in Clinton, making the total of removals in all four towns 510 buildings.

Since the beginning of the work the soil has been stripped from 3,943 acres, in order to fit the bottom of the reservoir for the purposes of water supply, and there have been removed 6,900,000 cubic yards of soil. By far the larger part of this soil has been deposited in the North Dike, but a considerable quantity has been placed in the South Dike. Large quantities have been used for filling shallow flowage areas, for deposit in highway and railroad embankments and for grading grounds near the dam.

In order to prepare the reservoir bottom for the filling with water anticipated during the year, a final or further cleaning of the bottom of the reservoir was made from elevation 363 up to elevation 385. This work principally consisted in the removal of weeds, grass and bushes which had grown up since the original stripping of the soil or since the last cleaning. As the reservoir was not filled, owing to the unusually dry season, above elevation 368, considerable work will have to be done during the coming year, or later, in again cleaning the bottom of the reservoir up to elevation 385 and beyond that to elevation 395, the elevation which will be reached when the reservoir is entirely filled.

The reservoir has an area within the water line of 6.44 square miles, or 4,123 acres, and beyond the water line there is a margin of 5.28 square miles, or 3,380 acres. The length of the water line is 38.66 miles. The reservoir when filled to the water line will contain 64,951,400,000 gallons.

The stripping of the soil and the removal of the material to the various places of deposit and other work done in the preparation of

the reservoir, including the building of the North and South dikes, have cost $3,414,837.61.

The additional sum of $2,834,485.88 was expended in payment for real estate taken for the construction of the reservoir.

### (c) *Forestry.*

The forestal work upon the marginal land about the reservoir has been continued during the past year. The Lamson nursery, so called, on the north side, and the Flagg nursery, so called, on the south side, have been maintained for the purpose of raising seedlings for transplanting. From these nurseries have been transplanted more than 188,075 seedlings and plants. This work has been accomplished over an area of 162 acres during the year. For the purpose the larger number of the seedlings used have been white pines, but there has also been a large number of white, Norway and Douglas spruces, besides many chestnuts and some Scotch pines, tamaracks, larches and locusts.

The area which has been planted with trees up to the present time comprises 1,099 acres, and there remains to be planted, as proposed, an area of 321 acres. It is expected that, in addition to the marginal strip along the shores of the reservoir, containing 197 acres, there will also remain open and not planted an area of 300 acres. Of the total 3,380 acres constituting the marginal land, so called, 1,463 acres were forested when acquired. White pines and arbor vitæ seedlings have also been planted during the year along the flow line of the marginal lands of the Commonwealth for a distance of about 4 miles, and some replacing of trees which had been planted in previous years in other parts has been done. There remain but 1½ miles to be planted along the flow line.

There remain in the original seed beds of the Flagg nursery 283,400 white pines and 101,500 arbor vitæ, and in transplanted beds 37,500 arbor vitæ. In the Lamson nursery there remain 20,500 sugar maples, 4,010 white oaks, 3,900 walnuts, 14,860 locusts, 2,400 ashes and 1,030 Norway spruces, all in transplanted beds.

In the making of a fire guard, so called, 40 feet wide, through the wooded parts of the margins of the Commonwealth's land, a further progress of 2¾ miles has been made. About 32 acres of land have been treated by the filling of holes or by grading after

the removal of houses and outbuildings, and put in proper condition and seeded.

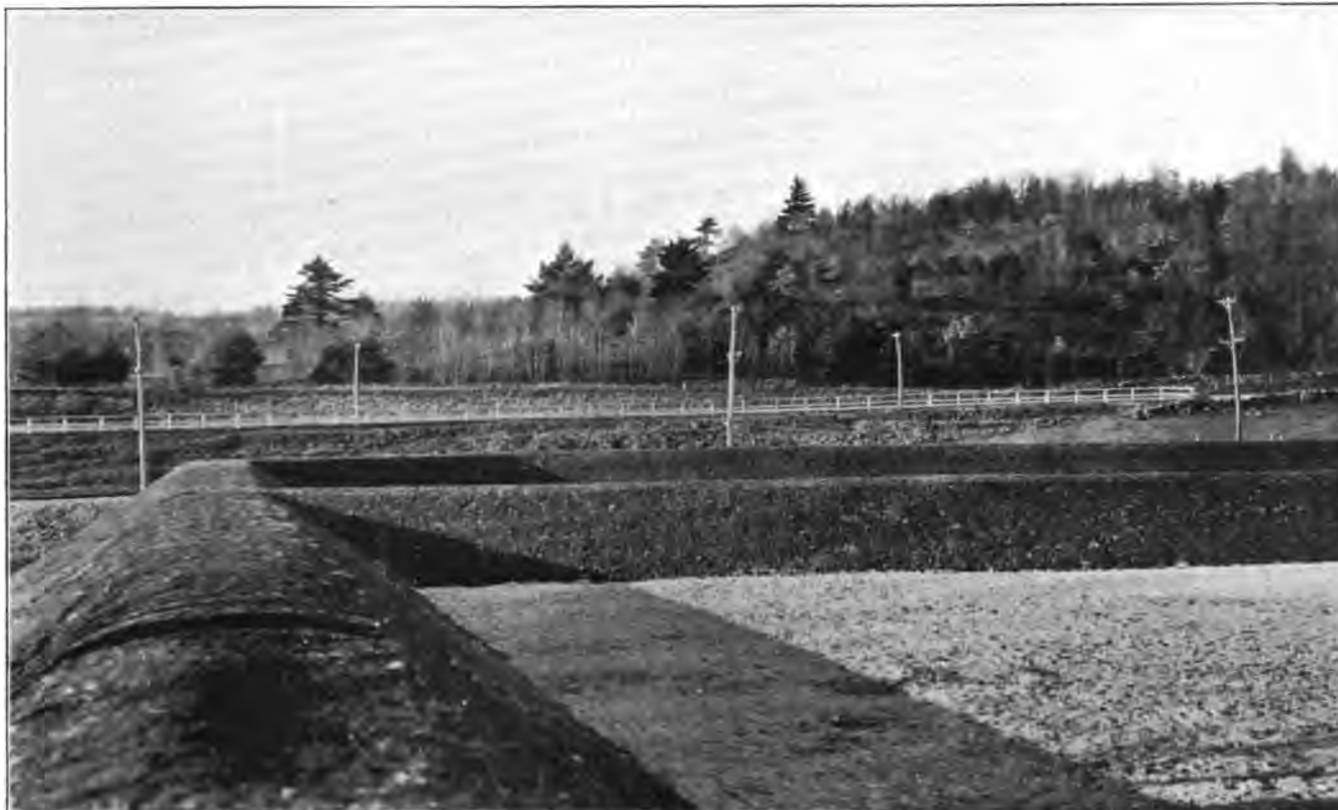
Considerable lumber and fire wood, as well as railroad ties, telephone poles and the like, have been obtained from the cutting out of the trees. The larger part of the lumber and other materials has been sold, but some have been reserved for use on the works.

### (*d*) *Location, Construction and Discontinuance of Roads.*

Although no new road has been laid out during the past year and no road has been discontinued, considerable work has been required upon the roads built in previous years. Inasmuch as Boylston Street in the town of Clinton had been badly worn by heavy teaming during the construction of the dam, it was deemed proper to resurface the road from the dam to the Boylston town line with broken stone. Newton Street in West Boylston was also surfaced with gravel for a distance of about 2,200 feet, and Crescent Street for a distance of about 2,600 feet. Much other work has been done upon various roads, in the paving of gutters, building of railings and fences, and in the repairs occasioned by the erosion or washing out of the road-beds.

### (*e*) *Clinton Catholic Cemetery.*

A tripartite agreement was entered into on July 1, 1898, between the Roman Catholic Bishop of the diocese of Springfield, the St. John's Catholic Cemetery Association of Clinton, and the Board, by which lands were to be acquired in the southerly part of the town of Lancaster for a new cemetery, and the bodies buried in the old cemetery were to be removed therefrom by the Cemetery Association to the new cemetery site. The Board on February 8, 1899, assented to a supplementary agreement, by which the work of the removal of the bodies was to be performed under the direction of a committee consisting of some of the officers of the Association and representatives of the lot owners, instead of being done by the Cemetery Association. Under these agreements the lands in Lancaster required for the new cemetery were purchased, and the title to the larger part was vested in the Commonwealth. The grounds were properly laid out and prepared for burial purposes, the bodies were all successfully removed from the site of the old cemetery and interred in the new, and all the monuments and other stones were



STERLING FILTER-BEDS on Brook emptying into Waushacum Pond on Wachusett Watershed.

reset, and the new cemetery has since been used for burial purposes.

Certification was made and notification given in the year 1900 that everything required by the agreement to be done prior to the final settlement had been accomplished. A considerable balance in money is due from the Commonwealth under the agreement, which provides that on the completion of the work the Bishop, who holds the title, shall convey to the Commonwealth the land formerly embraced in the old cemetery, with a release of damages, and thereupon the Board shall convey the lands in Lancaster, comprised in the new cemetery, to the St. John's Catholic Cemetery Association, and pay to the Association the balance of money due from the Commonwealth.

The Board has repeatedly, but without success, asked for the carrying out of the agreement for the release of the old cemetery site to the Commonwealth, in order that it may on its part, in accordance with its agreement, convey to the Cemetery Association the new cemetery grounds and pay over to the Association the balance of money payable.

## (2) Improvement of Wachusett Watershed.

### (a) *Sterling Filter-beds.*

The waters of a small brook, which has its rise in and about the village of Sterling Centre, flow into West Waushacum Pond and thence by way of the Stillwater River into the Wachusett Reservoir. This village has no sewerage system, and the conditions are such that the overflow from cesspools and other objectionable drainage might possibly run into the brook and thence into the reservoir. It was, therefore, determined to provide against pollution from this source by the building alongside the brook of four filter-beds, each having an area of one-half an acre, into which the water shall be diverted and by which it shall be filtered before entering the reservoir.

A contract for the construction of the beds was made, the work was begun early in September, and at the close of the year it had nearly reached completion. The sum of $9,971.14 had already been spent upon construction, but the land damages have not yet been determined.

### (b) *Drainage of Swamps.*

The construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir had been suspended in the year 1900, on account of other more pressing work. It was, however, determined during the past year to proceed with the work by the construction of ditches for the drainage of three of the swamps on the watershed, one south of Sterling Centre, and two situated north of the village of Quinepoxet, both partly in the town of Holden and partly in the town of Princeton. The three swamps have areas respectively of 26, 72 and 216 acres, with watersheds embracing a total of 2,600 acres. The work upon the two former has been completed, leaving that upon the larger one still unfinished. The drainage ditches constructed have a total length of 19,700 linear feet. The expenditures for the construction of these ditches, including culverts, farm crossings and watering places, not including engineering, for the year amounted to $9,886, and the work has been done by day labor.

### (c) *Miscellaneous Improvements.*

Considerable progress has otherwise been made in the accomplishment of the work for preventing the pollution of the Wachusett Reservoir in the towns of West Boylston, Boylston and Sterling. Twenty-eight cesspools, seven cemented vaults, a gravel filter-bed and a drainage ditch have been constructed, in order to prevent sewage and barn drainage from running into the brooks which empty into the reservoir. Other work of various kinds has been done about the Quinepoxet River, in order to prevent polluting matter from entering the streams.

## (3) Pumping Stations.

The construction of a new brick pumping station in Arlington for the high-service supply of that town and the town of Lexington was begun on August 27, 1906. This is to take the place of a temporary wooden structure which was erected on land purchased for the purpose of building a permanent station after the admission of the town into the Metropolitan Water District. The building has been about half completed, and during the coming year will be finished and equipped with a new pumping engine and boiler.

DITCHES FOR SWAMP DRAINAGE ON WACHUSETT WATERSHED IN HOLDEN.

Considerable work was done at the Chestnut Hill low-service pumping station for the purpose of so adapting one of the three new engines in that station that it may assist in supplying the demands for the high service. In this way it has been hoped that the necessity of purchasing a large new engine for the high service might be for a time deferred. The work to this end has so far seemed to be successful, and it is anticipated that the addition of a new high-service engine will not be required for the coming year.

### (4) Improvement of Spot Pond Brook.

No hearing has been called for during the year under the petition brought by the city of Melrose for the appointment of commissioners under chapter 406 of the Acts of the year 1904, which was an act "to provide for the improvement of Spot Pond Brook by the Metropolitan Water and Sewerage Board."

### (5) Police Protection.

The police protection called for by the Metropolitan Water Act for communities where the work of construction was carried on has ceased to be required. The last officers on duty, who were in the town of Clinton, were discharged, on account of the discontinuance of construction about the Wachusett Dam, on March 31, 1906.

A total sum of $210,801.74 has been paid, since the beginning of the work, for police protection during construction, in accordance with the requirements of the Metropolitan Water Act.

Some police service or guard is required about the Wachusett Reservoir, but, inasmuch as this is for the protection of the works, it is regarded as a part of the requirements of maintenance.

### (6) Acquisition of Lands and Settlements for Lands Acquired.

The Board acquired during the past year, by purchase, 229.153 acres in fee and easements in 1 acre, and by takings, 9.005 acres in fee and easements in 0.153 acre, — a total of 239.311 acres. The larger part of the lands acquired was situated in Sterling, considerable tracts situated upon and in the vicinity of the West Waushacum Lake having been purchased for the improvement of the watershed, and other parcels having been taken for the building of the filter-beds.

The total area of all the lands acquired for the Metropolitan Water Works since the beginning of operations in the year 1895 has amounted to 16,814.733 acres, or 26.273 square miles.

In some cases the acquisition of lands has first been made by deed, and in other cases takings under the powers given by the Metropolitan Water Act have first been made; but it has been the policy of the Board to follow the conveyances by takings, and, so far as possible, when settlement has been made after takings, to obtain releases by deed.

The number of takings of land made during the year was 7, but 5 of these covered land supposed to have been already acquired by deed.

*List of Takings for Metropolitan Water Works for the Year 1906.*

| No. | Location and Description. | Former Owners. | Recorded. | Purpose of Taking. |
|---|---|---|---|---|
| | | | 1906. | |
| 108 | Arlington (northwest from Brattle Street, adjoining Lexington & Arlington Branch of Boston & Lowell Railroad and the pumping station lot). Area, 0.015 acre in fee. | Sarah Hourty. | Aug. 21. | Addition to pumping station lot. |
| 109 | Sterling (southeasterly from Worcester Street, about one mile south from Sterling Centre, between locations of the Worcester Consolidated Street Railway Company and of the New York, New Haven & Hartford Railroad, Fitchburg & Worcester Branch). Area, 8.99 acres in fee and easements in 0.153 acre. | Helen M. Houghton *et al.*, Clara L. Kingsbury, Willie R. Mitchell, Charles O. Nixon. | Sept. 6. | Wachusett improvement (Sterling filter-beds). |
| 110 | Westborough (north of Haskell Street, east of State highway, adjoining land of the Westborough Insane Hospital). Area, 0.96 acre in fee. | Heirs of Levi A. Bathrick. | Dec. 31. | Crane Swamp improvement. |
| 111 | Berlin and Northborough (Berlin parcel between New York, New Haven & Hartford Railroad and North Brook; Northborough parcel on Berlin line and New York, New Haven & Hartford Railroad). Area, 4.274 acres in fee. | Lizzie J. Spofford and Lettie A. Knight. | Dec. 31. | Wachusett Aqueduct. |
| 112 | West Boylston (one parcel south of Holden Street and two parcels on Wilson Place). Area, 43.62 acres in fee. | Myron W. Houghton and Bela T. Chase. | Dec. 31. | Wachusett Reservoir. |
| 113 | Clinton and Boylston (on easterly side of new highway to Clinton, both sides of the Berlin road and of the old location of the Central Massachusetts Railroad). Area, 87.56 acres in fee. | Heirs of Lorenzo Wood. | Dec. 31. | Wachusett Reservoir. |
| 114 | Sterling and West Boylston (one piece east side Stillwater River, easterly from Waushacum Street; one piece on west side Waushacum Street, a short distance northeast from Main Street; and one at corner of Waushacum and North Main streets). Area, 55.504 acres in fee. | Emily Hosmer *et al.*, Joseph E. White and Mary S. Mason. | Dec. 31. | Wachusett Reservoir. |

Settlements under purchases and takings of land, for all purposes of the Water Works, have been effected in the past year in 16 cases, and for an aggregate of 538.526 acres with the buildings thereon. Of these cases, 6 were on account of the Wachusett Reservoir, 1 on account of the Weston Aqueduct, 1 on account of the taking of Spot Pond and the surrounding lands, 1 on account of Spot Pond Improvement, 3 for the improvement of the Wachusett watershed, 2 on account of the improvement of the Sudbury watershed and 2 on account of the Wachusett Aqueduct. The sums paid in all these settlements during the year 1906 have amounted to $976,278.40. In 4 of these cases the settlements have been results of suits at law, and the total amount paid in the court settlements during 1906 has been $900,-612.33. Payments on "account" previously made would make the total amount paid in these four cases $1,247,544.30, of which $1,214,523.63 was for Spot Pond and surrounding lands and $25,-705.99 for Spot Pond Improvement.

Since the beginning of operations upon the Metropolitan Water Works, the number of settlements effected on account of the acquisition of land for the purposes of the Water Works, including the works of water supply acquired from the city of Boston on January 1, 1898, has amounted to 867; and under them the Board has acquired rights, in fee or easements, in 16,491.876 acres, or 25.768 square miles, for which an aggregate of $18,245,741.16 has been paid. Only 48 of these cases have been settled by judgments obtained in court, and the total amount paid under these judgments has been $1,386,751.59, or less than 8 per cent. of the whole amount paid.

Of the lands acquired, either in fee or in easement, since the beginning of operations upon the Metropolitan Water Works, settlement has been effected with the owners of all these lands except 27.257 acres. This amount does not, however, include 69.75 acres in Lancaster, which the Board stands ready to convey to the St. John's Catholic Cemetery Association; and 40.059 acres of land in Clinton, of which the owners have not been found.

Not including the settlement with the city of Boston, which was effected by agreement out of court, and the settlement with the cities of Malden, Medford and Melrose for Spot Pond and surrounding lands, which was made upon the basis of an award by commissioners, the Board has obtained settlement by voluntary agreement with $^{17}/_{18}$ of all the owners of the lands acquired, and almost $^{24}/_{25}$ of the total

amount of money paid in settlements was under voluntary agreement with the owners.

The above purchases and takings for which the settlements have been made include lands taken in fee with the buildings thereon and the water and other rights connected therewith, and lands in which easements and other rights are taken; but they do not include settlements for diversion of water, depreciation and other damages connected with lands not acquired, and in which no fee or easement has been taken.

*Summary of Land Settlements for Water Works to December 31, 1906.*

| LOCATION. | For the Year 1906. | | | From Beginning of Work. | | |
|---|---|---|---|---|---|---|
| | Area in Acres. | Number of Settlements. | Payments. | Area in Acres. | Number of Settlements. | Payments. |
| *Wachusett Reservoir.* | | | | | | |
| Berlin, | - | 6 | $2,248 00 | 16.700 | 435 | $2,951,680 10 |
| Boylston, | - | | | 4,008.116 | | |
| Clinton, | .252 | | | 1,275.015 | | |
| Holden, | - | | | 167.000 | | |
| Sterling, | 27.750 | | | 797.987 | | |
| West Boylston, | .074 | | | 1,652.924 | | |
| Total, | 28.076 | 6 | $2,248 00 | 7,912.742 | 435 | $2,951,680 10 |
| *Improving Wachusett Watershed.* | | | | | | |
| Holden, | - | 3 | $72,500 00 | 151.340 | 8 | $133,460 00 |
| Sterling, | 229.150 | | | 229.150 | | |
| West Boylston, | - | | | 64.430 | | |
| Total, | 229.150 | 3 | $72,500 00 | 444.920 | 8 | $133,460 00 |
| *Wachusett Aqueduct.* | | | | | | |
| Berlin, | - | 2 | $3,953 10 | 47.815 | 70 | $81,677 08 |
| Clinton, | - | | | 12.310 | | |
| Marlborough, | - | | | 51.530 | | |
| Northborough, | - | | | 89.000 | | |
| Southborough, | 8.600 | | | 108.660 | | |
| Total, | 8.600 | 2 | $3,953 10 | 309.315 | 70 | $81,677 08 |
| *Sudbury Reservoir.*[1] | | | | | | |
| Marlborough, | - | - | - | 751.980 | 153 | $658,318 75 |
| Southborough, | - | | | 2,019.080 | | |
| Total, | - | - | - | 2,771.060 | 153 | $658,318 75 |

[1] Including settlements made by city of Boston.

*Summary of Land Settlements for Water Works, etc.* — Continued.

| LOCATION. | For the Year 1906. Area in Acres. | Number of Settlements. | Payments. | From Beginning of Work. Area in Acres. | Number of Settlements. | Payments. |
|---|---|---|---|---|---|---|
| *Improving Sudbury Watershed.* | | | | | | |
| Ashland, | - | 2 | - | .630 | 41 | $16,522 16 |
| Marlborough, | - | | | .800 | | |
| Northborough, | - | | | 178.049 | | |
| Sherborn, | 1.000 | | | 1.000 | | |
| Southborough, | .003 | | | 4.829 | | |
| Westborough, | - | | | 205.487 | | |
| Total, | 1.003 | 2 | - | 390.795 | 41 | $16,522 16 |
| *Clinton Sewerage System.* | | | | | | |
| Clinton, | - | - | - | 5.315 | 36 | $37,794 40 |
| Lancaster, | - | | | 129.835 | | |
| Total, | - | - | - | 135.150 | 36 | $37,794 40 |
| *Weston Aqueduct.* | | | | | | |
| Framingham, | .520 | 1 | $923 07 | 102.645 | 86 | $183,593 40 |
| Newton, | - | | | 1.308 | | |
| Southborough, | - | | | .450 | | |
| Wayland, | - | | | 73.299 | | |
| Weston, | - | | | 295.195 | | |
| Total, | .520 | 1 | $923 07 | 472.897 | 86 | $183,593 40 |
| *Distribution System.* | | | | | | |
| Arlington, | - | - | - | 1.896 | 34 | $171,916 85 |
| Boston, | - | | | 1.359 | | |
| Brookline, | - | | | .051 | | |
| Malden, | - | | | .158 | | |
| Medford, | - | | | 3.213 | | |
| Newton, | - | | | 5.147 | | |
| Quincy, | - | | | 5.224 | | |
| Revere, | - | | | .404 | | |
| Somerville, | - | | | .009 | | |
| Stoneham, | - | | | 19.409 | | |
| Total, | - | - | - | 36.870 | 34 | $171,916 85 |
| *Improving Lake Cochituate.* | | | | | | |
| Natick, | - | - | - | 2.950 | 1 | $1,600 00 |
| Total, | - | - | - | 2.950 | 1 | $1,600 00 |

*Summary of Land Settlements for Water Works, etc.* — Concluded.

| LOCATION. | For the Year 1906. | | | From Beginning of Work. | | |
|---|---|---|---|---|---|---|
| | Area in Acres. | Number of Settlements. | Payments. | Area in Acres. | Number of Settlements. | Payments. |
| *Spot Pond Water Works (Taking of January 1, 1898).* | | | - | | | |
| Medford, | .630 | 1 | $888,158 32 | .630 | 1 | $1,214,523 63[1] |
| Stoneham, | 216.000 | | | 216.000 | | |
| Total, | 216.630 | 1 | $888,158 32 | 216.630 | 1 | $1,214,523 63 |
| *Spot Pond Improvement (Takings of August 5, 1899, and June 2, 1902).* | | | | | | |
| Medford, | 41.447 | 1 | $8,500 91 | 41.447 | 1 | $25,706 99 |
| Stoneham, | 13.100 | | | 13.100 | | |
| Total, | 54.547 | 1 | $8,500 91 | 54.547 | 1 | $25,706 99 |
| *Boston Water Works[2] (Taking of January 1, 1898).* | | | | | | |
| Arlington, | - | - | - | 1.586 | 1 | $12,768,948 80[3] |
| Ashland, | - | | | 652.124 | | |
| Boston, | - | | | 160.630 | | |
| Framingham, | - | | | 663.460 | | |
| Hopkinton, | - | | | 654.729 | | |
| Marlborough, | - | | | 30.552 | | |
| Medford, | - | | | 25.140 | | |
| Natick, | - | | | 436.223 | | |
| Needham, | - | | | 81.695 | | |
| Newton, | - | | | 78.308 | | |
| Sherborn, | - | | | 40.385 | | |
| Somerville, | - | | | 12.426 | | |
| Southborough, | - | | | 17.168 | | |
| Wayland, | - | | | 177.875 | | |
| Wellesley, | - | | | 139.115 | | |
| Westborough, | - | | | 545.912 | | |
| Winchester, | - | | | 76.094 | | |
| Woburn, | - | | | .578 | | |
| Total, | - | - | - | 3,744.000 | 1 | $12,768,948 80 |
| Aggregates, | 538.526 | 16 | $976,278 40 | 16,491.876 | 867 | $18,245,741 16 |

[1] Includes $749.71 paid city of Malden for supplies not part of award.
[2] Estimated areas.
[3] Includes interest.

The settlements above enumerated include all lands acquired for which a complete settlement has been made. About 114.402 acres of the lands acquired and settled for have subsequently been sold and conveyed by the Board. This does not include 0.204 of an acre in Natick, taken for abolition of grade crossing.

The tables of settlements for lands acquired do not include: —

1. Lands for which "payments on account" under chapter 317 of the Acts of the year 1904 have been made, there being 4.89 acres on account of which $1,278.07 has been paid, but for which no settlement has been reached.

2. Lands acquired but not paid or settled for, amounting to about 144.139 acres, including 50.765 acres previously owned by the Commonwealth and 66.761 acres of other lands for which no claims will probably be made.

3. Lands embraced in the St. John's Catholic Cemetery, comprising 26.39 acres in Clinton and 69.75 acres in Lancaster.

4. Areas of streets.

### (7) Claims and Settlements for Loss of Business.

For injury to business caused by the carrying out of the Metropolitan Water Act in the towns of Boylston and West Boylston and in portions of the towns of Sterling and Clinton, settlements were made during the year in 17 cases, and in addition 2 cases were disallowed. In some of these cases claims had been previously filed with the Board, but in the greater number suits for damages had been directly brought in court. These suits were brought after the decision of the Supreme Judicial Court declaring that under certain circumstances farming was an established business within the meaning of the Metropolitan Water Act, for which damages could be recovered. Settlements were accordingly effected in several of these suits by the Attorney-General, with the approval of the Board.

The number of claims of this class settled since the beginning of the Water Works has been 322, and the total sum paid on account of such claims has been $153,222.36. All of these claims except 18 have been settled outside of the court.

### (8) Claims and Settlements for Loss of Employment.

No claims for loss of employment by residents of West Boylston have been filed during the year, but 3 settlements of cases of this class already pending have been made. These 3 claims had been rejected by the Board, but were allowed by the courts.

The whole number of settlements for such claims effected since the beginning of the operations of the Board has been 477. The total amount paid on account of these claims has been $85,959.65. All of these claims, with the exception of the 3 paid the past year, were settled without resort to the courts.

### (9) Claims and Settlements for Depreciation of Real Estate.

Settlements for depreciation in the value of real estate not taken by the Board were made on account of lands situated in the towns of West Boylston and Sterling only, all of the Clinton cases having been previously settled. Settlements have been effected in 10 cases of this class during the year ending December 31, 1906, and the sum of $6,974.02 has been paid. Of these, 1 was settled in court.

The total number of claims for depreciation settled up to December 31, 1906, has been 275, and the total amount paid thereunder has been $265,459.51. All of these claims except 42 were settled out of court.

No settlements or results have been reached in the many suits for damages brought under the Act of the year 1904, which gave to the owners of real estate situated in that part of the town of Boylston lying on the southerly and southeasterly sides of the reservoir, and within the limits of the Nashua River watershed, the right to recover for the depreciation in value of real estate not taken but injured by reason of the operations of the Metropolitan Water and Sewerage Board in a manner similar to that provided for owners of real estate in the town of West Boylston.

### (10) Claims on Account of Diversion of Water.

There have been no claims filed during the year for damages for the diversion of water. The total sum paid under settlements and judgments for such claims since the beginning of the construction of the Water Works has been $1,135,708.91.

The sums enumerated as paid in these and in the preceding cases do not include amounts paid for expert services and court expenses.

## IV. WATER WORKS — MAINTENANCE.

Dexter Brackett, the Engineer of the Sudbury and Distribution departments, has had supervision over the maintenance and operation of all the Water Works of the Metropolitan System. He has been assisted by Charles E. Haberstroh, who has the immediate supervision of the Sudbury and Cochituate works and of the portion of the Weston Aqueduct above the Weston Reservoir; by George E. Wilde, who has the immediate supervision of the Weston Reservoir and the remainder of the Weston Aqueduct, and of all the reservoirs and pipe lines within the Metropolitan District; and by Arthur E. O'Neil, who has charge of the several pumping stations. Alexander E. Kastl, Division Engineer, has had the immediate charge of both construction and maintenance of the Wachusett Dam, Reservoir and Aqueduct, and of the Clinton Sewerage Works.

### (1) Operation of Works.

The maintenance of the Water Works embraces the care and operation of the five water pumping stations, of the Pegan pumping station and of the Clinton sewerage pumping station, the ten storage reservoirs, the ten distributing reservoirs, the four aqueducts, the various filter-beds, the 84 miles of distributing main pipes, as well as the various pipe yards, gate-houses, siphon and terminal chambers, and other structures connected with the several reservoirs and aqueducts, the dwellings for attendants, and various other buildings used or held for operating purposes. There are in addition the Mystic pumping station and the Mystic Aqueduct, which have not been in active operation during the past year.

### (2) Storage Reservoirs.

The storage reservoirs of the Cochituate and Sudbury watersheds have normal capacities amounting to 15,858,500,000 gallons, though a somewhat larger amount of water is at certain periods actually held by them. The new Wachusett Reservoir has a capacity of 64,951,400,000 gallons, so that the total capacity of the storage

reservoirs is 80,809,900,000 gallons. The various capacities are as follows: —

| | Gallons. |
|---|---|
| Cochituate watershed: — | |
| Lake Cochituate, including Dudley Pond, | 2,242,400,000 |
| Sudbury watershed: — | |
| Sudbury Reservoir, | 7,253,500,000 |
| Framingham Reservoir No. 1, | 287,500,000 |
| Framingham Reservoir No. 2, | 529,900,000 |
| Framingham Reservoir No. 3, | 1,183,500,000 |
| Ashland Reservoir, | 1,416,400,000 |
| Hopkinton Reservoir, | 1,520,900,000 |
| Whitehall Reservoir, | 1,256,900,000 |
| Farm Pond, | 167,500,000 |
| Wachusett watershed: — | |
| Wachusett Reservoir, | 64,951,400,000 |
| Total, | 80,809,900,000 |

On January 1, 1906, the quantity of water stored in all of the storage reservoirs was 28,971,900,000 gallons. There was a considerable gain made during the month of January, but greater gains occurred from the larger rainfalls of the latter part of February and of the months of March and April, and from a single rainfall near the end of May. The maximum amount in storage was reached on July 6, when the quantity stored in all the reservoirs was 49,805,-200,000 gallons. This quantity is by far the largest amount of water held in storage at any time, the maximum quantity in the preceding year being 33,708,200,000 gallons. After July 6 there was almost continual loss of storage in the reservoirs, and at the end of the year the quantity in storage was 44,153,200,000 gallons.

Considerable progress has been made during the past year in filling the Wachusett Reservoir, although the yield of the watershed was below the average of past years, and the requirements of the service have caused large quantities of water to be drawn daily from this reservoir. On January 1, 1906, the reservoir contained 17,115,-300,000 gallons. The water in the reservoir reached its greatest height on July 10, when the reservoir contained 34,462,500,000 gallons. This quantity was more than half of the capacity of the reservoir, and the water rose to elevation 367.75 above Boston City Base, which is 27.25 feet lower than the level of the reservoir if filled to high-water mark. The quantity of water in storage on

December 31, 1906, was 31,752,900,000 gallons, — a net gain in storage for the year of 14,637,600,000 gallons. The only water discharged from the reservoir into the river below the dam is that provided, in accordance with the statute, for the use of the Lancaster Mills. The average quantity thus discharged was 3,761,000 gallons per day.

The Sudbury Reservoir, which receives all the water furnished to the District through the Wachusett Aqueduct from the Wachusett Reservoir, was during the year full or nearly full for 7 months, the water having flowed continuously over the crest of the dam into Framingham Reservoir No. 3, which is directly below upon the river. The water is drawn from the Sudbury Reservoir substantially during the entire year, a part by way of Framingham Reservoir No. 3 through the Sudbury Aqueduct, and a part through the Weston Aqueduct. Water was drawn from Framingham Reservoir No. 2 during the whole or portions of 6 months; from Ashland Reservoir during portions of 2 months; from the Hopkinton Reservoir during portions of 6 months. Water was drawn from Framingham reservoirs Nos. 1 and 2 in order to increase the supply in Lake Cochituate during portions of 6 months of the year. Water was drawn from Lake Cochituate during 9 months of the year. The water in this lake was lowered toward the latter part of the year, largely in order to make certain repairs which had been found necessary, so that in the middle of November the surface of the lake was 7 feet 6 inches below high water.

It was found necessary to rebuild a portion of the barn at the Sudbury Dam, as it had become unsafe for use. The grounds near the dam have been improved by the covering of wastes which had been left after construction. Trees have also been set out near the dam and at various points around the reservoir. Considerable fencing has been done in connection with adjoining proprietors.

A portion of the house occupied by the gate-keeper at the Ashland Reservoir was destroyed by fire, and that part has been rebuilt.

At Lake Cochituate it was found necessary to replace the flume in the circular dam which was used for keeping the northerly section of the lake, formerly known as the Fiske Meadow, covered with water at times when the level of the water in the lake has been more than usually drawn down. The wooden flume of the dam was replaced by a flume built of Portland cement concrete. The water in

this section of the lake being then so drawn down, the opportunity was afforded to make a thorough cleaning of this basin, and a certain portion of the shore was improved by excavation, so as to prevent shallow flowage.

The usual ordinary repairs have been made at all of the reservoirs.

The number of persons who come to visit the Wachusett Dam has been so great during the summer season that it has been necessary to have several of the men qualified as special policemen and put on duty on Sundays and holidays, so as to preserve order and protect the grounds from damage.

## (3) Distributing Reservoirs.

The distributing reservoirs have a capacity of 2,381,230,000 gallons, and are usually kept filled or nearly filled with water. The capacities of these reservoirs are as follows: —

| | Capacity in Gallons. |
|---|---|
| Spot Pond, | 1,791,700,000 |
| Chestnut Hill Reservoir, | 300,000,000 |
| Weston Reservoir, | 200,000,000 |
| Fells Reservoir, | 41,400,000 |
| Mystic Reservoir, | 26,200,000 |
| Waban Hill Reservoir, | 13,500,000 |
| Forbes Hill Reservoir, | 5,100,000 |
| Bear Hill Reservoir, | 2,450,000 |
| Arlington Standpipe, | 550,000 |
| Forbes Hill Standpipe, | 330,000 |
| Total, | 2,381,230,000 |

These reservoirs are all situated within the Metropolitan District, and are maintained not only for facilitating the distribution of water, but also to afford protection in cases of emergency. The Weston Reservoir also serves the purpose of an equalizing reservoir near the end of the Weston Aqueduct.

Considerable work has been required for the reconstruction of the gravel walks and resurfacing of a portion of the driveway about the Chestnut Hill Reservoir, made necessary by the changing of the grade of Beacon Street by the city of Boston.

The visitors to the buildings and grounds at several of the distributing reservoirs, particularly on Sundays and holidays, call for

a considerable extra force upon such days for the protection of the works and grounds.

During the past year the Arlington standpipe has been emptied and thoroughly cleaned and painted. The grounds about several of the reservoirs have been much infested by the gypsy and brown-tail moths, and a more extended report of their ravages is given in subsequent pages.

### (4) Aqueducts.

Water was drawn through the Wachusett Aqueduct from the Wachusett Reservoir into the Sudbury Reservoir 316 days during the past year, an average of 80,764,000 gallons per day. At the times when the aqueduct was not in use it was thoroughly cleaned, and the structures along the line have been painted and needed repairs have been made.

From the Sudbury Reservoir an average of 32,289,000 gallons per day was drawn through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 68,363,000 gallons per day, coming principally from the Sudbury Reservoir, was drawn through the Sudbury Aqueduct. In addition, an average of 5,634,000 gallons per day was drawn through the Sudbury Aqueduct from Framingham reservoirs Nos. 1 and 2, making in the aggregate an average of 73,997,000 gallons per day drawn through the Sudbury Aqueduct. The Sudbury Aqueduct was in service 359 days during the year. Besides the usual cleaning of the aqueduct and of the three siphon pipes, joints in the masonry of the siphon chambers and of several of the culverts and waste weirs were repointed, and considerable painting was done for the preservation of the iron and wood work.

The Weston Aqueduct was in operation 355 days. The aqueduct and structures were given the annual cleaning, and some fencing was done along the aqueduct for its protection.

Water was drawn through the Cochituate Aqueduct a total of 237 days, an average of 13,288,000 gallons per day. In addition to the making of usual repairs, accurate surveys for locating the aqueduct and determining the position of property bounds, which have been in progress for several years, were finished, and the most of the alignment and property bounds had been set.

### (5) Pumping Stations.

About 73 per cent. of all of the water supplied to the Metropolitan District has been first received through the Chestnut Hill Reservoir or directly from the aqueducts near the reservoir, and pumped at the Chestnut Hill high-service and low-service stations. The remainder of the water received was delivered into the distribution system by gravity through the Weston Aqueduct. A somewhat larger proportion than last year of the water supplied was thus delivered by gravity. From the Chestnut Hill low-service pumping station the water is pumped to the lower districts of Boston, Somerville, Chelsea, Malden, Medford, Everett and Arlington, and also to Spot Pond. The water is pumped from the Chestnut Hill high-service station to the higher districts of Boston, and to Quincy, Watertown, Belmont and a part of Milton. Water is pumped a second time from Spot Pond to Melrose, Revere, Winthrop, Nahant, Swampscott and the higher portions of Somerville, Chelsea, Malden, Medford and Everett; from a station in Arlington to Lexington and the higher portions of Arlington; and from a station in West Roxbury to the higher portions of West Roxbury and Milton.

The total quantity of water pumped at all of the stations during the year was 35,180,570,000 gallons, or 805,660,000 gallons less than the preceding year, a considerably less quantity of water being pumped at the Chestnut Hill low-service station than during the preceding year. The cost of operating all of the stations was $102,377.95, or $2.91 per million gallons pumped, — an increase of 30 cents per million gallons over the corresponding cost in the preceding year. Though this increase in cost of pumping is somewhat due to increase in the cost of fuel, it is partly due to the increased cost of labor and to the increase in the number of employés made necessary by a reduction in the hours of labor from seven days to six days per week.

The cost per million gallons of water raised one foot was: for the Chestnut Hill high-service station, $0.027; for the Chestnut Hill low-service station, $0.033; for the Spot Pond station, $0.031; for the West Roxbury station, $0.216; for the Arlington station, $0.095. These figures show an increase in the cost at the Chestnut Hill high and low service stations and in the West Roxbury station, a slight decrease in the Arlington station, and no change in the Spot Pond station.

Considerable difficulty has been had with the pumping engine at the Arlington pumping station, but it is expected that by temporary repairs the engine can be used until the new engine for the station, which is in process of building, can be installed and put to service.

During the year 12,623.88 tons of coal were purchased for use at the various stations. Of this total, 9,265.52 tons were bituminous, 363.37 tons anthracite, 2,655.95 tons buckwheat anthracite, and 702.41 tons were anthracite screenings. The average price per gross ton for the bituminous coal varied at the different stations from $4.12 to $4.48. The cost of the anthracite used was $7.28, of the buckwheat anthracite $2.84 and $2.93, and of anthracite screenings $2.24 and $2.52.

Tests have been continued in order to determine the heating value of the coal used and offered for use in the several stations, and also to determine the viscosity, specific gravity and burning point of the oil used.

### (6) Pipe Lines and Pipe Yards.

Three breaks in the pipes have occurred during the year. The first occurred in the small pipes supplying water to the low-service station at Chestnut Hill; but a more serious one was the sudden breaking of the 48-inch curved casting in one of the force mains at the Chestnut Hill high-service station, which caused the flooding of the basement of the building and considerable damage to the grounds in the vicinity before it was possible to stop the flow of water. The third break occurred in a curve of the 48-inch pipe in Melrose, which was broken by the sewer department of that city while blasting for a sewer trench. The water had been shut off earlier in the day at the request of the Melrose authorities, and the cost of repairing the break was paid by the city of Melrose. Twenty-four leaks in pipes were discovered and repaired, the leaks being generally due to defective leaded joints.

To facilitate the construction of a new conduit by the Cambridge Water Works a main in Watertown was lowered, and in Medford a main pipe was raised to permit of the construction of a water drain by the city. Considerable changes and repairs have been made in the pipe line crossing Chelsea Creek between Chelsea and East Boston. Several insulating joints have been set at various points, for the purpose of attempting to reduce the quantity of electric current flowing along the pipes.

For the purpose of measuring the water supplied to the different cities and towns in the District, two new meters have been introduced and two of the meters originally placed have been enlarged. There are now in service for this purpose 55 Venturi meters and 4 Hersey meters.

The Glenwood pipe yard, so called, in Medford, is maintained as the headquarters of the maintenance force of the Water Works in the northern part of the District. The maintenance force for the southern part of the District has headquarters in buildings at the Chestnut Hill Reservoir.

### (7) Sewerage and Filtration Works.

#### (a) *Clinton Sewerage Works.*

The daily average quantity of sewage pumped and filtered at the Clinton Sewerage Works was 23.6 per cent. more than in the preceding year. This increase was due to the amount of water leaking into the local sewers during the heavier rainfalls of the year.

The average quantity of sewage pumped per day was 795,000 gallons, and the cost per million gallons raised one foot was $0.19.

There are now in use 8 settling basins and 25 filter-beds. Experiments have been in progress during the year, under the supervision of the Chief Engineer of the State Board of Health, in order to increase the efficiency of the beds and to improve the character of the effluent.

The cost of operating the pumping station has been $2,731.23 and of the maintenance of the filter-beds $2,020.14, an amount of $6.96 per million gallons filtered. The sum of $1,087.37 has been expended in the experimental work.

The sludge which has accumulated in the settling basins and filter-beds has been given to the neighboring farmers, who have been glad to take it away and dispose of it upon their farms.

#### (b) *Marlborough Brook Filter-beds.*

The Marlborough Brook filter-beds, which receive the waters of a brook that flows through a section of the city of Marlborough before they enter the Sudbury Reservoir, have been in successful operation during the entire year. All the water flowing from the brook has

been filtered before entering the reservoir, except some small quantities on two days when there were heavy rainfalls. The beds have been cleaned and kept in good condition.

### (c) *Pegan Brook Filtration Works.*

The Pegan filter-beds receive the water directly from Pegan Brook which flows through portions of the town of Natick, and also the water from the intercepting ditch which collects the water received from other brooks formerly draining into this section of Lake Cochituate, then known as the Pegan Brook Meadow. Water was pumped upon the filter-beds on 191 days during the year. The total quantity pumped during the year was 246,525,000 gallons, of which 158,739,000 gallons came from the Pegan Brook and 87,786,000 gallons came from the intercepting ditch.

The cost of operating the pumping station and of cleaning and caring for the beds and grounds was $17.50 per million gallons pumped.

## (8) Sanitary Work and Regulations.

The sanitary inspection of the Wachusett, Sudbury and Cochituate watersheds has been continued, under the direction of William W. Locke, C.E. He has had two regular assistants, and laborers and others have been employed from time to time as required to carry out the improvements and changes which have been ordered.

There were 11 cases of typhoid fever reported during the year upon the Wachusett watershed, and 44 cases reported upon the Sudbury and Cochituate watersheds. None of these cases occurred upon lands belonging to the Board. All of them, however, were investigated as soon as reported, and proper precautions were taken to prevent the pollution of the water supply. So far as known, the purity of the water supply has not been affected by any of these cases.

There were inspected during the year 1,450 premises on the Wachusett watershed, for the purpose of ascertaining whether there were any conditions needing corrections or improvement, particularly with reference to cesspools, privy and sink drainage, manure piles and manufacturing wastes. Of these, 1,280 were declared to be satisfactory at the end of the year, and 170 premises were pronounced "unsatisfactory," which classification includes all cases where there

may be under the most unfavorable conditions wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering brooks or feeders to the reservoir, although some attempts may have been made to purify them. Remedies were effected by the agents of the Board in 62 cases, 5 of them being remedied by the construction of filter-beds, and the remaining 57 by the building of new cesspools and cemented vaults or by the tearing down or removal of buildings. Partial remedy was applied in 39 other cases.

On the Sudbury and Cochituate watersheds 7,502 premises were inspected, and 7,148 of these were pronounced satisfactory at the end of the year and 354 unsatisfactory. In the cases of 202 of the premises remedies were effected by the agents of the Board, 192 by introducing sewer connections and 10 by other means, and there were 27 premises where partial remedies were accomplished. In addition, connections were made with 37 new houses.

Improvement in sanitary conditions has also been accomplished for the Wachusett watershed by the tearing down or removal of 30 dwelling houses, 10 barns and 1 storehouse on property owned by the Board. One of the mills on the Quinepoxet River, where 50 men had been formerly employed in the manufacture of cloths, was purchased by the Board and was destroyed. A large tract of land upon the southerly and westerly shores of West Waushacum Lake, extending along the margin of the lake about 3,000 feet was acquired and purchased, together with the farm or boarding house and several summer cottages standing upon the land.

At the Whitehall Reservoir more strict inspection has been adopted for the prevention of bathing, and measures have been taken toward the restriction of boating.

Samples of water have been collected at monthly and bi-monthly periods from different points upon the works, and sent to the State Board of Health for analysis and examination. Collections are made much more frequently for the microscopical and biological examinations in the laboratory of the Board. During the past year 2,526 microscopical and 1,017 biological examinations were thus made of the water collected from the main feeders of the Sudbury Reservoir and Framingham Reservoir No. 3 and of Lake Cochituate, as well as monthly tests made to determine the efficiency of the Marlborough Brook filter-beds.

## (9) Moth Suppression.

The gypsy and brown-tail moths were found during the past year not only in extended areas in places where they had previously existed, but also in places where they had not formerly been discovered. The regions about Spot Pond have been, as heretofore, much the worse infested, and upon them the largest part of the work of suppression has been carried on. In the early part of the year a large force of men was employed in painting the egg clusters of the gypsy moth with creosote and fuel oil, and later in the season the foliage of the trees and the shrubbery were sprayed with arsenate of lead.

About Spot Pond the larger trouble has come from the presence of the gypsy moth, but considerable work has been done in the destruction of the nests of the brown-tail moths. In places the trees have been encircled with tanglefoot. Much difficulty was experienced in the attempt to protect the southern area of the Spot Pond lands along the long line between the land of the Commonwealth and that of the city of Medford. Much has been accomplished, and little serious damage has come to the trees on the land of the Commonwealth in the custody of the Board.

The lands at the Chestnut Hill and Mystic reservoirs have been more or less infested by both gypsy and brown-tail moths, and considerable work has been done in the destruction of egg clusters and nests. The moths have been advancing along the Cochituate, Sudbury and Weston aqueducts, and have been found in considerable numbers about the Sudbury and Weston reservoirs, and the brown-tail moths have been discovered even upon the grounds about the Wachusett Dam in Clinton.

The work which has been done for the suppression of the ravages of the moths in these regions as well as about Spot Pond has been sufficient to prevent the destruction of the trees or their serious injury. The operations have been carried on by the regular water maintenance force, augmented from time to time, as has been found necessary, by the employment of other experienced men. The total amount expended during the year was $12,700, of which all but about $2,200 was spent on the lands about Spot Pond.

## (10) Quality of the Water.

The water delivered to the Metropolitan District has been substantially of the same quality during the last three or four years. During the past year the color of the water has been somewhat less, while the number of microscopic organisms has somewhat increased. No complaints regarding the quality of the water have been received from water takers during the year.

The organisms which prevail more or less in the different reservoirs, and sometimes give the water a noticeable taste or color, are in no respect injurious to the public health. In the Wachusett Reservoir the number of organisms has been small, and they have never imparted an objectionable character to the water. A larger number appeared for a while in the Sudbury Reservoir, and there was a slightly objectionable odor in the water, but they were broken up by passing the water over the Sudbury Dam. There are times in the year when the number is also large in Lake Cochituate and in other reservoirs, and at such times the water is not drawn from these sources. The additional storage given to the water in Spot Pond has caused this water generally to be particularly unobjectionable. Sufficient water has not yet been kept in storage in the Wachusett Reservoir to obtain the full benefit to be expected in the future from long storage in that basin.

## (11) The Water Supply.

The amount of water yielded by both the Sudbury and Wachusett watersheds was considerably below the average, although this amount was larger than during the preceding year, in which the yield was abnormally small. The rainfall on the Sudbury watershed was 44.48 inches, only 1.56 inches below the average; and the rainfall on the Wachusett watershed was 49.08 inches, which is but little below the average. This rainfall, however, did not yield a proportional amount of water, because it was more widely distributed during the year, and there was but a comparatively small rainfall during the months when the larger quantity of water is collectible in the reservoirs. The yield of the Sudbury watershed was 19 per cent. less than the average, and that of the Wachusett was 14 per cent. below the average.

Water was supplied not only to all the cities and towns included

within the Metropolitan Water District, except the city of Newton and the town of Hyde Park, but was also supplied, by a special agreement, to the town of Swampscott, which is without the limits of the District, and to a small part of the town of Saugus, which is directly supplied by the town of Revere, under an arrangement with the Board. The estimated population, as of July 1, 1906, of the territory supplied with water was 913,710.

The city of Newton and the town of Hyde Park continue to be supplied from their own sources, which are still adequate for the purpose; and these municipalities are charged, in accordance with the Metropolitan Water Act, as amended in the year 1904, with one-fifth of the assessment which they would have been called upon to pay on the basis of valuation, and are relieved from any charge made on the basis of consumption.

The total quantity of water supplied by the Metropolitan Water Works to the various cities and towns, as determined by pump measurement and by the flow through the Weston Aqueduct, together with the small quantity yielded by Spot Pond, was 43,369,310,000 gallons, an average daily supply of 118,820,000 gallons, which is an increase in the daily supply of 422,000 gallons. The daily average supplied for each inhabitant was 130 gallons,—a slight decrease from last year, when the average was 131.2 gallons.

In addition to the amount thus supplied to the cities and towns in the District, 45,000 gallons daily were supplied to the United States reservation on Peddock's Island, in accordance with arrangements made with the Government.

The town of Framingham was also permitted, under the law, to draw its supply from Farm Pond, but this supply did not enter the aqueducts.

The quantity of water, as measured by the Venturi meters, when delivered to the various municipalities is, owing to leakage from the different reservoirs and pipe lines, as well as in a small degree to the use of water at the pumping stations, somewhat less than the amount given above, the quantity so measured and supplied from the Metropolitan Works to each person daily being 128 gallons.

The city of Newton and the town of Hyde Park supplied from their sources to their respective inhabitants a total of 1,191,546,533 gallons, being a daily average of 62 gallons per inhabitant.

## V. WATER WORKS — FINANCIAL STATEMENT.

By chapter 235 of the Acts of the year 1906, the Board was required on or before the third Wednesday in January of each year to report to the General Court an abstract of its receipts, expenditures, disbursements, assets and liabilities for the previous fiscal year (which, by the provisions of chapter 211 of the Acts of the year 1905, is the year beginning with the first day of December and ending with the thirtieth day of November), together with all recommendations for legislation which it deemed desirable; and the Board was also required by the Act of 1906 to present in the month of February a more detailed statement of its doings for the calendar year next preceding, which detailed statement should be printed as its annual report for the year.

The financial abstract for the eleven months of the fiscal year ending with the thirtieth day of November, 1906,[1] was accordingly presented to the General Court in January, and a copy of this financial abstract is printed as Appendix No. 5.

The following detailed statement of its financial doings, in relation to the Metropolitan Water Works, for the calendar year 1906, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $40,500,000. To this sum are added the proceeds from the sale of certain property by the Board, and these amounted on January 1, 1907, to $148,361.41. The total amount, therefore, which the Board has been authorized to expend is $40,648,361.41. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1906, $1,234,662.79, and the total amount so approved for payment since the beginning of the work up to January 1, 1907, has been $40,278,877.02. There was accordingly a balance remaining at the beginning of the year 1907 amounting to $369,484.39.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $40,193,000.

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[1] Since the Act of 1905 changing the fiscal year came into full effect on the first day of January, 1906, the financial abstract submitted in January, 1907, covered only the period of the eleven months of the year 1906 ending with November 30.

These bonds were issued for terms of 39½ and 40 years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1907 to $4,897,822.62.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1906, which was paid out of the annual assessments, was $419,748.23.

The assessments for the year 1906, for the payment of interest on the bonds, for the sinking fund requirements, and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,262,657.20.

Receipts from sales of water to municipalities not belonging to the District and to water companies were distributed back to the cities and towns, in proportion to their respective assessments, to the amount of $19,475.53.

The detailed financial statement regarding the Metropolitan Water Works is as follows: —

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS:

The loans for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1907, have been as follows: —

| | |
|---|---|
| Loan under chapter 488 of the Acts of 1895, . . . . . . | $27,000,000 00 |
| Loan under chapter 453 of the Acts of 1901, . . . . . . | 13,000,000 00 |
| Loan under chapter 367 of the Acts of 1906, . . . . . . | 500,000 00 |
| | $40,500,000 00 |
| Proceeds from the sales of property applicable to the construction and acquisition of works (of which $24,595.91 is for the year 1906), . . . . . . . . . . . . . . . | 148,361 41 |
| | $40,648,361 41 |
| Amount approved by the Metropolitan Water and Sewerage Board for payments to December 31, 1906 (of which $1,234,662.79 is for the year 1906), . . . . . . . . . . . . . | 40,278,877 02 |
| Balance January 1, 1907, . . . . . . . . . . . | $369,484 39 |

## (2) Issues of Metropolitan Water Loan Bonds.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $40,500,000, to be designated the "Metropolitan Water Loan," has sold bonds as follows: —

| Date of Sale. | Amount of Bonds sold. | Rate of Interest (per cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Sept. 25, 1895, | $5,000,000 | 3½ | 110.67 | July 1, 1935, | $533,500 00 |
| Nov. 23, 1896, | 2,000,000 | 3½ | 106.76268 | July 1, 1935, | 135,253 60[1] |
| Feb. 8, 1897, | 6,000,000 | 3½ | 107.82 | July 1, 1935, | 469,200 00 |
| Jan. 13, 1898, | 2,000,000 | 3½ | 113.176 | Jan. 1, 1938, | 263,520 00 |
| Mar. 2, 1898, | 2,000,000 | 3½ | 112.877 | Jan. 1, 1938, | 257,540 00 |
| June 15, 1899, | 3,000,000 | 3 | 100.64 | July 1, 1939, | 19,200 00 |
| June 28, 1900, | 1,000,000 | 3 | 102.78 | July 1, 1939, | 27,800 00 |
| Mar. 5, 1901, | 3,000,000 | 3 | 102.155 | Jan. 1, 1941, | 64,650 00 |
| July 24, 1901, | 100,000 | 3 | 100.375 | Jan. 1, 1941, | 375 00 |
| July 24, 1901, | 150,000 | 3 | 100.10 | Jan. 1, 1941, | 150 00 |
| July 30, 1901, | 205,000 | 3 | 100.25 | Jan. 1, 1941, | 512 50 |
| July 31, 1901, | 50,000 | 3 | 100.25 | Jan. 1, 1941, | 125 00 |
| Aug. 7, 1901, | 50,000 | 3 | 100.50 | Jan. 1, 1941, | 250 00 |
| Aug. 8, 1901, | 300,000 | 3 | 100.10 | Jan. 1, 1941, | 300 00 |
| Aug. 8, 1901, | 200,000 | 3 | 100.25 | Jan. 1, 1941, | 500 00 |
| Sept. 17, 1901, | 3,100,000 | 3½ | 106.71 | Jan. 1, 1941, | 208,010 00 |
| Oct. 1, 1901, | 1,345,000 | 3 | 100. | Jan. 1, 1941, | - |
| Oct. 24, 1901, | 1,500,000 | 3 | 100. | Jan. 1, 1941, | - |
| Feb. 26, 1902, | 500,000 | 3½ | 109.13 | Jan. 1, 1942, | 45,650 00 |
| Feb. 26, 1902, | 3,000,000 | 3½ | 109.13 | Jan. 1, 1942, | 273,900 00 |
| April 7, 1903, | 250,000 | 3½ | 106.725 | Jan. 1, 1943, | 16,812 50 |
| April 17, 1903, | 1,250,000 | 3½ | 106.1329 | Jan. 1, 1943, | 76,661 25 |
| Jan. 15, 1904, | 500,000 | 3½ | 104.60 | Jan. 1, 1943, | 23,000 00 |
| Jan. 15, 1904, | 2,000,000 | 3½ | 104.60 | Jan. 1, 1944, | 92,000 00 |
| Mar. 24, 1905, | 650,000 | 3½ | 105.761 | Jan. 1, 1945, | 37,446 50 |
| June 28, 1906, | 943,000 | 3½ | 108.09 | Jan. 1, 1946, | 29,138 70 |
| June 28, 1906, | 100,000 | 3½ | 100. | Jan. 1, 1946, | - |
| | $40,193,000 | | | | $2,575,495 05 |

[1] Including $18,673.60 from readjustment of rate made by the Treasurer in 1897.

## (3) Metropolitan Water Loan Sinking Fund.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

| | |
|---|---|
| December 31, 1895, | $226,286 05 |
| December 31, 1896, | 699,860 70 |
| December 31, 1897, | 954,469 00 |
| December 31, 1898, | 1,416,374 29 |
| December 31, 1899, | 1,349,332 97 |
| December 31, 1900, | 1,573,619 72 |
| December 31, 1901, | 1,662,426 95 |
| December 31, 1902, | 2,256,803 81 |
| December 31, 1903, | 2,877,835 59 |
| December 31, 1904, | 3,519,602 92 |
| December 31, 1905, | 4,207,045 69 |
| December 31, 1906, | 4,897,822 62 |

### (4) Annual Assessments and Receipts.

Assessments for the year, amounting to $2,262,657.20, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,336,775.37; for the sinking fund, $520,-380.51; and for maintenance and operation, $405,501.32. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

| | | | |
|---|---|---|---|
| Arlington, | $13,663 68 | Nahant, | $4,187 88 |
| Belmont, | 5,668 67 | Newton, | 6,234 22 |
| Boston, | 1,822,556 33 | Quincy, | 46,314 16 |
| Chelsea, | 57,687 81 | Revere, | 16,894 21 |
| Everett, | 39,583 12 | Somerville, | 97,160 08 |
| Hyde Park, | 1,242 52 | Stoneham, | 8,088 06 |
| Lexington, | 6,205 30 | Watertown, | 14,778 34 |
| Malden, | 38,087 38 | Winthrop, | 13,351 69 |
| Medford, | 31,653 25 | | |
| Melrose, | 25,230 09 | | $2,262,657 20 |
| Milton, | 14,070 41 | | |

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its sources, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property, are, in accordance with the provisions of the Water Act, applied to the reduction of the assessment, and these, for the year 1906, amounted to $7,693.75.

The actual expenditures for the maintenance and operation of the Metropolitan Water Works were, for the year 1906, $419,748.23.

### (5) Distribution to Cities and Towns of Sums received from Water furnished to Other Municipalities.

Sums have been received during the year 1906, under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

| | |
|---|---|
| Swampscott, | $4,800 00 |
| United States Government, | 796 19 |
| Wakefield, | 200 00 |
| | $5,796 19 |

The Treasurer, in accordance with the requirements of the Act, distributed to the cities and towns of the District, in proportion to the annual assessments theretofore contributed by them, to which were added considerable sums which had been received in the preceding year too late for distribution. The distribution was made as follows: —

| | | | |
|---|---|---|---|
| Arlington, | $114 46 | Nahant, | $32 46 |
| Belmont, | 58 46 | Newton, | 95 38 |
| Boston, | 15,886 82 | Quincy, | 313 55 |
| Chelsea, | 416 77 | Revere, | 141 16 |
| Everett, | 303 80 | Somerville, | 800 30 |
| Hyde Park, | 28 50 | Stoneham, | 66 48 |
| Lexington, | 34 38 | Watertown, | 137 96 |
| Malden, | 433 42 | Winthrop, | 88 06 |
| Medford, | 253 78 | | |
| Melrose, | 182 82 | | $19,475 53 |
| Milton, | 86 97 | | |

## (6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| Administration applicable to all parts of the construction and acquisition of the works, | . . . | $10,926 77 | | $262,601 46 |
| Wachusett Dam and Reservoir: — | | | | |
| Wachusett Dam, | $87,472 43 | | $2,270,116 85 | |
| North Dike, | 303 06 | | 749,811 36 | |
| South Dike, | 1,574 26 | | 186,871 10 | |
| Removal of soil, | 36,293 76 | | 2,528,155 15 | |
| Relocation of railroads, | 16,648 62 | | 876,995 94 | |
| Roads and bridges, | 15,947 78 | | 545,144 26 | |
| Real estate, | 17,380 19 | | 3,179,060 57 | |
| Damages, real estate not taken, business and loss of wages, | 10,374 02 | | 504,641 52 | |
| Other expenses, | 267 50 | 186,261 57 | 6,740 42 | 10,797,537 17 |
| Improving Wachusett watershed, | | 101,996 14 | | 188,035 81 |
| Wachusett Aqueduct, | | 4,094 60 | | 1,797,694 80 |
| Sudbury Reservoir, | | - | | 2,922,445 21 |
| Protection of Sudbury supply, | | 393 80 | | 129,190 36 |
| *Amounts carried forward,* | . . . | $303,672 88 | | $16,097,504 81 |

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $303,672 38 | | $16,097,504 81 |
| Improving Sudbury watershed, | | 278 16 | | 95,385 09 |
| Protection of Cochituate supply, | | - | | 9,000 00 |
| Improving Cochituate watershed, | | - | | 8,860 68 |
| Improving Lake Cochituate, | | - | | 103,537 29 |
| Pipe lines, Dam No. 3 to Dam No. 1, | | - | | 48,471 48 |
| Pipe line, Rosemary siphon, | | - | | 23,142 98 |
| Weston Aqueduct:— | | | | |
| Aqueduct, | $2,173 20 | | $2,352,136 32 | |
| Reservoir, | 382 26 | | 288,684 36 | |
| Supply pipe lines, | 287 93 | | 584,639 71 | |
| Real estate, taxes and other expenses, | 1,364 82 | | 204,486 03 | |
| | | 4,208 21 | | 3,429,946 42 |
| Distribution system:— | | | | |
| Low service:— | | | | |
| Pipe lines and connections, | $420 39 | | $1,751,626 06 | |
| Pumping station, Chestnut Hill, | 3,320 22 | | 462,572 19 | |
| Reservoir, Spot Pond, | - | | 578,101 58 | |
| Gate-house and connections, Chestnut Hill Reservoir, | - | | 65,480 88 | |
| Real estate and other expenses, | - | | 90,910 66 | |
| Northern high service:— | | | | |
| Pipe lines and connections, | - | | 440,539 28 | |
| Spot Pond pumping station, | - | | 291,829 35 | |
| Fells Reservoir, Stoneham, | - | | 141,892 94 | |
| Bear Hill Reservoir, Stoneham, | - | | 38,267 70 | |
| Real estate and other expenses, | - | | 14,838 05 | |
| Southern high service:— | | | | |
| Pipe lines and connections, | 5,352 14 | | 514,897 55 | |
| Pumping station, Chestnut Hill, | 104 17 | | 242,225 52 | |
| Forbes Hill Reservoir, Quincy, | - | | 90,003 49 | |
| Waban Hill Reservoir, Newton, | - | | 61,592 11 | |
| Real estate and other expenses, | - | | 10,226 36 | |
| Northern extra high service, | 15,215 71 | | 29,243 86 | |
| Southern extra high service, | 15 00 | | 22,830 67 | |
| Meters and connections, | 567 91 | | 76,964 91 | |
| Improving Spot Pond Brook, | 274 18 | | 3,991 23 | |
| Glenwood pipe yard, | - | | 33,100 59 | |
| Chestnut Hill pipe yard, | - | | 11,311 26 | |
| | | 25,269 72 | | 4,971,946 24 |
| Diversion of water, South Branch of Nashua River,[1] | | 2,429 46 | | 1,360,240 46 |
| Acquisition of existing water works:— | | | | |
| Reimbursement city of Boston, partially constructed Sudbury Reservoir, | - | | $1,157,921 59 | |
| To Boston, for works taken January 1, 1898, | - | | 12,768,948 80 | |
| *Amounts carried forward,* | - | $335,857 93 | $13,926,870 39 | $26,148,035 45 |

[1] Of the total expenditures from the beginning of the work, the sum of $150,734.04 is for Clinton sewerage system.

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | - | $835,857 93 | $13,926,870 39 | $26,148,035 45 |
| Acquisition of existing water works — *Con.* | | | | |
| To Malden, Medford and Melrose for taking of Spot Pond, | $896,659 23 | | 1,240,229 62 | |
| To Newton, for Waban Hill Reservoir, | - | | 60,000 00 | |
| | | | $15,227,100 01 | |
| Transfers of works acquired and other property to accounts for special works, | - | | 1,240,262 50 | |
| | | | $13,986,837 51 | |
| Engineering, conveyancing, etc., | 2,600 00 | 899,259 23 | 73,126 22 | 14,059,963 73 |
| | | $1,235,117 16 | | |
| *Pipes, Valves, Castings, etc., sent first to Storage Yards, and afterwards transferred as needed to Different Parts of the Work.* | | | | |
| Sent to storage yards, | $1,864 18 | | $2,088,374 70 | |
| Transferred from storage yards to works, and included in costs above, | 2,318 55 | | 2,017,496 86 | |
| Balance from beginning of work, | | | | 70,877 84 |
| Excess of transfers over purchases during the year 1906 (deducted), | | 454 37 | | |
| Total for constructing and acquiring of works, | | $1,234,662 79 | | $40,278,877 02 |

| Maintenance and Operation. | For the Year ending December 31, 1906. | |
|---|---|---|
| Administration, | | $11,329 36 |
| General supervision, | | 4,320 54 |
| Taxes and other expenses, | | 44,744 23 |
| Wachusett Reservoir Department: — | | |
| General superintendence, | $2,460 22 | |
| Reservoir, | 70,104 97 | |
| Forestry, | 5,709 19 | |
| Sanitary inspection and protection of supply, | 1,427 74 | |
| Protection of supply, | 923 98 | |
| Buildings and grounds, | 2,273 76 | |
| Dam and aqueduct, | 4,906 20 | |
| Wachusett dam, | 3,075 95 | |
| Wachusett aqueduct, | 2,328 93 | |
| Clinton sewerage system: — | | |
| Pumping station, | 2,663 81 | |
| Sewers, screens and filter-beds, | 2,307 56 | |
| Sanitary inspection, | 458 92 | |
| | | 98,641 23 |
| *Amount carried forward,* | | $159,035 36 |

| Maintenance and Operation. | For the Year ending December 31, 1906. | |
|---|---|---|
| *Amount brought forward*, | . . . | $159,035 36 |
| Sudbury Department: — | | |
| General superintendence, | $3,764 31 | |
| Superintendence, Framingham office, | 7,754 73 | |
| Ashland Reservoir, | 3,240 18 | |
| Hopkinton Reservoir, | 2,130 81 | |
| Whitehall Reservoir, | 883 22 | |
| Framingham Reservoirs, 1, 2 and 3, | 4,513 21 | |
| Sudbury Reservoir, | 7,310 23 | |
| Lake Cochituate, | 7,094 47 | |
| Marlborough Brook filters, | 2,300 22 | |
| Pegan filters, | 4,814 79 | |
| Sudbury and Cochituate watersheds, | 431 96 | |
| Sanitary inspection, | 3,058 24 | |
| Cochituate Aqueduct, | 6,548 31 | |
| Sudbury Aqueduct, | 9,348 42 | |
| Weston Aqueduct, | 5,718 39 | |
| Biological laboratory, | 2,856 26 | |
| | | 70,767 75 |
| Distribution Department: — | | |
| Superintendence, | $10,346 93 | |
| Arlington pumping station, pumping service, | 6,461 52 | |
| Chestnut Hill low-service pumping station, pumping service, | 85,611 24 | |
| Chestnut Hill high-service pumping station, pumping service, | 47,215 34 | |
| Spot Pond pumping station, pumping service, | 11,400 90 | |
| West Roxbury pumping station, pumping service, | 7,370 57 | |
| Arlington standpipe, | 553 50 | |
| Bear Hill Reservoir, | 210 86 | |
| Chestnut Hill Reservoir, | 10,037 05 | |
| Fells Reservoir, | 1,265 27 | |
| Forbes Hill Reservoir, | 1,156 11 | |
| Mystic Lake, conduit and pumping station, | 2,171 28 | |
| Mystic Reservoir, | 1,295 88 | |
| Waban Hill Reservoir, | 604 94 | |
| Weston Reservoir, | 2,483 92 | |
| Spot Pond, | 16,954 48 | |
| Buildings at Spot Pond, | 1,451 84 | |
| Pipe lines: — | | |
| Low service, | 10,145 65 | |
| Northern high service, | 2,706 50 | |
| Southern high service, | 3,375 06 | |
| Supply pipe lines, | 784 87 | |
| Buildings at Chestnut Hill, | 1,827 29 | |
| Chestnut Hill pipe yard, | 472 26 | |
| Glenwood pipe yard and buildings, | 4,098 63 | |
| Stables, | 5,096 59 | |
| Waste prevention, | 2,924 43 | |
| Venturi meters, | 1,922 21 | |
| | | 189,945 12 |
| Total for maintaining and operating works, | . . . | $419,748 23 |

## (7) Detailed Financial Statement under Metropolitan Water Act.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1906.

### (a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1906, and ending December 31, 1906, is $1,234,662.79, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1906, is $40,278,877.02.

For maintenance and operation the expenditures for the year have been $419,748.23, and from the beginning of the work, $2,650,962.24.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

| General Character of Expenditures. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| Construction of Works and Acquisition by Purchase or Taking. | | | | |
| *Administration.* | | | | |
| Commissioners, | $4,666 67 | | $110,310 25 | |
| Secretary and auditor, | 1,500 00 | | 47,217 03 | |
| Clerks and stenographers, | 3,064 36 | | 55,572 49 | |
| Legal services, | - | | 2,359 00 | |
| Travelling, | 34 40 | | 3,625 48 | |
| Stationery and printing, | 585 75 | | 10,767 84 | |
| Postage, express and telegrams, | 126 10 | | 2,754 07 | |
| Furniture and fixtures, | - | | 4,280 89 | |
| Alterations and repairs of buildings, | 9 00 | | 5,752 27 | |
| Telephone, lighting, heating, water and care of building, | 544 46 | | 10,900 09 | |
| Rent and taxes, main office, | 341 41 | | 4,617 21 | |
| Miscellaneous expenses, | 54 62 | $10,926 77 | 4,444 84 | $262,601 46 |
| *Amounts carried forward,* | . . . | $10,926 77 | | $262,601 46 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | . . . | $10,926 77 | | $262,601 46 |
| *Engineering.* | | | | |
| Chief engineer and department engineers, | $4,105 38 | | $206,515 56 | |
| Principal assistant engineers, | 6,382 12 | | 151,607 61 | |
| Engineering assistants, | 22,458 42 | | 1,007,158 82 | |
| Consulting engineers, | - | | 28,560 07 | |
| Inspectors, | 476 50 | | 290,122 39 | |
| Architects, | 961 66 | | 36,161 19 | |
| Railroad and street car travel, | 44 30 | | 26,779 49 | |
| Wagon hire, | 951 68 | | 44,808 48 | |
| Stationery and printing, | 404 46 | | 25,870 75 | |
| Postage, express and telegrams, | 128 55 | | 7,703 91 | |
| Engineering and drafting instruments and tools, | 44 05 | | 19,284 78 | |
| Engineering and drafting supplies, | 308 21 | | 24,807 36 | |
| Books, maps and photographic supplies, | 175 75 | | 6,801 34 | |
| Furniture and fixtures, | - | | 14,977 46 | |
| Alterations and repairs of buildings: — | | | | |
| Main office, | 99 00 | | 14,038 86 | |
| Sub-offices, | 1 00 | | 2,939 36 | |
| Telephone, lighting, heating, water and care of buildings: — | | | | |
| Main office, | 1,573 76 | | 23,401 15 | |
| Sub-offices, | 997 20 | | 19,446 36 | |
| Rent and taxes, main office, | 1,024 28 | | 13,620 03 | |
| Rent of sub-offices and other buildings, | 13 00 | | 4,526 74 | |
| Field offices and sheds, | - | | 1,274 49 | |
| Clinton office building, | - | | 9,866 87 | |
| Unclassified supplies, | 29 43 | | 8,240 53 | |
| Miscellaneous expenses, | 89 92 | 40,258 57 | 8,624 19 | 1,992,137 79 |
| *Construction.* | | | | |
| Preliminary work (borings, test pits and other investigations): — | | | | |
| Advertising, | - | | $6,306 22 | |
| Other preliminary work as given in detail in preceding annual report, | - | | 155,457 41 | 161,763 63 |
| Contracts, Wachusett Reservoir: — | | | | |
| Contracts completed and final payments made prior to January 1, 1906, | - | | $2,644,147 23 | |
| Busch Bros., excavating soil, Sect. 6, and building road, West Boylston and Boylston, — deducted from estimate, September 5, 1900, | $600 00 | | 35,160 63 | |
| The H. Gore Co., surfacing highways, West Boylston, Sect. 1, | 398 82 | | 6,856 09 | |
| Sundry bills paid under this contract, | 1,000 00 | | 1,000 00 | |
| The H. Gore Co., surfacing highways, West Boylston, Sect. 2, | 467 91 | | 8,526 58 | |
| Sundry bills paid under this contract, | 1,263 90 | | 1,263 90 | |
| *Amounts carried forward,* | $3,730 63 | $51,185 34 | $2,696,954 43 | $2,416,502 88 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* . . . | $3,730 63 | $51,185 34 | $2,696,954 48 | $2,416,502 88 |
| *Construction* — Con. | | | | |
| Contracts, Wachusett Reservoir — *Con.* | | | | |
| Newell & Snowling Construction Co., excavating soil from Sect. 8 and completing westerly portion of North Dike (deducted from final estimate), . . . . . . | 500 00 | | 500 00 | |
| Bruno, Salomone & Petitti, Sect. 10, Wachusett Reservoir, Boylston and West Boylston, . . . . . . . . . . | 26,027 24 | | 543,680 45 | |
| McArthur Bros. Co., building Sect. 2 of the relocation of Central Massachusetts Railroad, . . . . . . . . . . | 18,920 00 | | 286,209 39 | |
| Francis A. McCauliff, masonry arch bridge at West Boylston, . . . . . . | 1,576 56 | | 12,809 65 | |
| McBride & Co., Stillwater improvement, . | - | | 23,314 67 | |
| Sundry bills paid under this contract, . | 296 40 | | 3,459 45 | |
| John F. Magee & Co., South Dike, . . | 720 00 | | 138,608 54 | |
| Sundry bills paid under this contract, . | 780 00 | | 780 00 | |
| McArthur Bros. Co., riprap at South Dike, | - | | 15,385 24 | |
| McArthur Bros. Co., Wachusett Dam, . | 46,465 99 | | 1,605,855 73 | |
| Francis A. McCauliff, granite posts, curbing and edgestones, Wachusett Dam, . . | 1,700 00 | | 1,700 00 | |
| Henry Parsons & Son, steel gates and fencing for Wachusett Dam, . . . . . | 1,349 00 | | 1,349 00 | |
| J. H. McCafferty & Co., brass railing for Wachusett Dam, . . . . . . . . | 4,185 00 | | 4,185 00 | |
| Simpson Bros. Corp., reinforced granolithic surface on Wachusett Dam, . . . . | 2,452 72 | | 2,452 72 | |
| | | 108,703 54 | | 5,337,244 27 |
| Contracts improving Wachusett Watershed: — | | | | |
| A. McKenzie & Co., Sterling filter-beds, . | | 8,490 09 | | 8,490 09 |
| Contracts completed, Wachusett Aqueduct, . | - | | | 1,447,208 55 |
| Contracts completed, Sudbury Reservoir, . | - | | | 1,545,028 83 |
| Contracts completed, protection Sudbury Supply: — | | | | |
| City of Marlborough, main sewer, . . | - | | | 9,000 00 |
| Contracts completed, improving Lake Cochituate, . . . . . . . . . . | - | | | 60,657 45 |
| Contracts completed, protection Cochituate Supply: — | | | | |
| Town of Framingham, low-level sewer, . | - | | | 9,000 00 |
| Contracts completed, Rosemary siphon, . . | - | | | 5,916 96 |
| Contracts completed, pipe line, Dam No. 3 to Dam No. 1, . . . . . . . . | - | | | 17,240 22 |
| Contracts completed, Clinton sewerage system, . . . . . . . . . . | - | | | 66,878 22 |
| Contracts, Weston Aqueduct: — | | | | |
| Contracts completed and final payments made prior to January 1, 1906, . . . | - | | $1,781,564 31 | |
| *Amounts carried forward,* . . . . | - | $163,378 97 | $1,781,564 31 | $10,923,166 97 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward*, | - | $163,878 97 | $1,781,564 31 | $10,923,166 97 |
| *Construction* — Con. | | | | |
| Contracts, Weston Aqueduct — *Con.* | | | | |
| Shanahan, Casparis & Co., Sect. 2, | - | | 201,827 74 | |
| Sundry bills paid under this contract, | - | | 2,911 80 | |
| Shanahan, Casparis & Co., Sect. 3, | - | | 126,420 70 | |
| Sundry bills paid under this contract, | - | | 4,214 78 | |
| Shanahan, Casparis & Co., Sect. 6, | - | | 108,933 26 | |
| Sundry bills paid under this contract, | $45 00 | | 7,018 05 | |
| Shanahan, Casparis & Co., Sect. 12, | - | | 138,151 78 | |
| Sundry bills paid under this contract, | - | 45 00 | 3,339 77 | 2,374,377 19 |
| Contracts, Distribution System: — | | | | |
| Contracts completed and final payments made prior to January 1, 1906, | - | | $4,385,494 64 | |
| C. A. Dodge & Co., Arlington pumping station, | $11,190 44 | | 11,190 44 | |
| R. D. Wood & Co, special castings, | 421 99 | 11,612 43 | 2,279 27 | |
| | | | $4,398,964 35 | |
| Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900, | - | | 3,139 77 | 4,395,824 58 |
| Additional work: — | | | | |
| Labor, | $36,990 18 | | $690,780 01 | |
| Professional services, medical services, analyses, etc., | 20 00 | | 1,819 01 | |
| Travelling, | 105 60 | | 2,532 82 | |
| Rent, | - | | 3,556 73 | |
| Water rates, | 14 80 | | 1,454 77 | |
| Freight and express, | 553 34 | | 12,650 99 | |
| Jobbing and repairing, | 204 19 | | 9,619 15 | |
| Tools, machinery, appliances, and hardware supplies, | 872 68 | | 73,112 10 | |
| Electrical supplies, | - | | 4,924 68 | |
| Castings, ironwork and metals, | 5,745 51 | | 73,565 24 | |
| Iron pipe and valves, | 1,981 50 | | 57,918 61 | |
| Blasting supplies, | 23 40 | | 1,362 88 | |
| Paint and coating, | 115 75 | | 4,314 63 | |
| Fuel, oil and waste, | 81 02 | | 10,464 11 | |
| Lumber and field buildings, | 2,493 02 | | 84,242 42 | |
| Drain pipe, | 163 03 | | 9,087 31 | |
| Brick, cement and stone, | 1,157 61 | | 25,161 42 | |
| Sand, gravel and filling, | 104 25 | | 6,857 81 | |
| Municipal and corporation work, | - | | 208,166 67 | |
| Police service, | 505 00 | | 210,801 74 | |
| Sanitary inspection, | 483 84 | | 13,010 09 | |
| Judgments and settlements for damages, | 4,280 80 | | 46,763 86 | |
| Unclassified supplies, | 803 93 | | 16,107 29 | |
| Miscellaneous expenses, | 1,357 26 | 58,056 21 | 4,443 09 | 1,672,717 48 |
| *Amounts carried forward*, | | $233,092 61 | | $19,266,086 22 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $233,092 61 | | $19,266,086 22 |
| *Construction* — Con. | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $4,668 82 | |
| Expert services, | - | | 1,862 66 | |
| Court expenses, | $258 16 | | 1,167 20 | |
| Miscellaneous expenses, | - | | 171 05 | |
| | | 258 16 | | 7,869 73 |
| *Real Estate.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $4,736 31 | |
| Conveyancer and assistants, | $3,058 00 | | 107,172 97 | |
| Experts, | - | | 17,871 58 | |
| Appraisers, | 196 39 | | 22,157 75 | |
| Court expenses, | 507 13 | | 10,330 43 | |
| Counsel expenses, | - | | 43 25 | |
| Conveyancing supplies, | 5 50 | | 3,161 08 | |
| Conveyancing expenses, | 58 26 | | 5,852 60 | |
| Miscellaneous expenses, | - | | 4,195 81 | |
| Settlements made by Board, | 72,528 00 | | 3,362,598 84 | |
| Judgments, | 7,341 17 | | 166,441 75 | |
| Taxes and tax equivalents, | - | | 68,182 41 | |
| Care and disposal, | 6,140 52 | | 80,752 65 | |
| | | 89,829 97 | | 3,853,497 38 |
| *Damages to Real Estate not taken, to Business and on Account of Loss of Wages.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $1,130 67 | |
| Expert services, | - | | 1,685 08 | |
| Court expenses, | $925 00 | | 12,495 29 | |
| Settlements, | 4,180 00 | | 401,445 32 | |
| Judgments, | 6,194 02 | | 103,196 20 | |
| | | 11,299 02 | | 519,902 56 |
| *Claims on Account of Diversion of Water.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $3,774 98 | |
| Expert services, | - | | 19,339 69 | |
| Court expenses, | $966 80 | | 20,072 49 | |
| Miscellaneous expenses, | 57 00 | | 1,279 63 | |
| Settlements, | - | | 917,350 00 | |
| Judgments, | - | | 218,358 91 | |
| | | 1,023 80 | | 1,180,175 70 |
| *Purchase of Existing Water Works.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $1,878 89 | |
| Expert services, | - | | 13,569 82 | |
| Court expenses, | $2,500 00 | | 29,728 38 | |
| Miscellaneous expenses, | - | | 1,470 94 | |
| Settlements and judgments, | 896,659 23 | | 15,227,100 01 | |
| | | 899,159 23 | | 15,273,748 04 |
| *Relocation Central Massachusetts Railroad.* | | | | |
| Settlements, | | - | | 177,597 39 |
| Total amount of construction expenditures, | | $1,234,662 79 | | $40,278,877 02 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | |
|---|---|---|
| **Maintenance and Operation of Works.** | | |
| Administration: — | | |
| Commissioners, | $4,666 66 | |
| Secretary, auditor and assistants, | 4,011 67 | |
| Postage, printing, stationery and other supplies, | 1,160 48 | |
| Travelling, | 322 20 | |
| Telephone, heating, lighting and care of building, | 443 15 | |
| Alterations and repairs of building, | 15 45 | |
| Rent and taxes, office building, | 424 74 | |
| Miscellaneous expenses, | 285 01 | |
| | | $11,329 36 |
| Supervision and general superintendence: — | | |
| Chief engineer and department engineers, | $7,605 75 | |
| Engineering and clerical assistants, | 8,066 38 | |
| Postage, printing, stationery and office supplies, | 769 23 | |
| Telephone, heating, lighting and care of offices, | 1,327 39 | |
| Travelling and incidental expenses, | 778 60 | |
| Alterations and repairs of buildings, | 663 24 | |
| Rent and taxes, main office, | 1,274 28 | |
| Miscellaneous expenses, | 407 13 | |
| | | 20,892 00 |
| Pumping service: — | | |
| Labor, | $50,866 56 | |
| Fuel, | 49,002 85 | |
| Oil, waste and packing, | 1,144 50 | |
| Repairs and renewals, | 4,300 01 | |
| Small supplies and expenses, | 1,972 61 | |
| Rent, West Roxbury pumping station, | 773 04 | |
| | | 108,059 57 |
| Superintendents and assistant superintendents, | $3,809 81 | |
| Engineering assistants, | 11,508 05 | |
| Laboratory force, | 2,264 62 | |
| Sanitary inspectors, | 3,336 50 | |
| Recording and scientific instruments and supplies, | 430 28 | |
| Labor and teaming, | 113,812 43 | |
| Tools, machinery and appliances, | 1,496 45 | |
| Lumber and hardware supplies, | 3,897 76 | |
| Jobbing and repairing, | 2,256 15 | |
| Travelling, | 3,182 97 | |
| Horses, vehicles and stable expenses, | 5,708 15 | |
| Fuel, lighting and telephone, | 4,758 28 | |
| Municipal and corporation work, | 93 09 | |
| Unclassified supplies, | 6,805 02 | |
| Miscellaneous expenses, | 4,857 25 | |
| Conveyancer and assistants, | 30 00 | |
| Taxes and tax equivalents, | 44,714 23 | |
| Contracts and agreements, | 1,282 45 | |
| Contracts for pipes, valves, etc., bought from construction work since January 1, 1906, | 240 81 | |
| Clinton award, chapter 498, Acts of 1906, | 64,988 00 | |
| | | 279,467 30 |
| Total expenditures for maintenance and operation, | . . . | $419,748 23 |

## (*b*) *Receipts.*

The total amount of receipts from rents, sales of property, etc., for the year beginning January 1, 1906, and ending December 31, 1906, is $38,085.85; and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1906, is $500,306.21. The general character of these receipts is as follows: —

| General Character of Receipts. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| For distribution back to District: — | | | | |
| District entrance fees, | - | | $92,265 00 | |
| Supplying water outside of District, | $5,796 19 | | 90,675 78 | |
| Water furnished to water companies, | - | $5,796 19 | 37,145 88 | $220,086 66 |
| To the credit of the loan fund: — | | | | |
| Real estate and buildings, | $5,988 81 | | $33,641 46 | |
| Labor, tools, supplies and reimbursements, | 18,607 10 | 24,595 91 | 114,719 95 | 148,361 41 |
| To the credit of the sinking fund: — | | | | |
| Forfeiture for contracts awarded but not executed, | - | | $500 00 | |
| Rents, | $2,179 48 | | 88,325 61 | |
| Land products, | 5,308 51 | | 40,493 95 | |
| Unclassified receipts and interest, | 205 76 | 7,693 75 | 2,538 58 | 131,858 14 |
| Total receipts, | . . . | $38,085 85 | | $500,306 21 |

The foregoing receipts have been credited to the various objects or works, as follows: —

| Receipts from Different Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| Distribution back to District: — | | | | |
| Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton and Lexington), | - | | $92,265 00 | |
| Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge and U. S. Government), | $5,796 19 | | 90,675 78 | |
| Water furnished to water companies, | - | $5,796 19 | 37,145 88 | $220,086 66 |
| *Amounts carried forward,* | . . . | $5,796 19 | - | $220,086 66 |

| Receipts from Different Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $5,796 19 | | $220,086 66 |
| Construction and acquisition of works: — | | | | |
| Administration, | - | | $42 15 | |
| Wachusett Dam, | $724 57 | | 5,624 88 | |
| Wachusett Reservoir, | 12,095 43 | | 133,183 28 | |
| Wachusett Aqueduct, | - | | 5,204 70 | |
| Weston Aqueduct, | 115 66 | | 4,863 13 | |
| Sudbury Reservoir and watershed, | 458 16 | | 7,735 42 | |
| Distribution system, | 3,284 73 | | 65,089 15 | |
| Diversion of water, Clinton sewerage system, | - | | 1,277 94 | |
| Purchase of existing water works, | 6,783 36 | 23,461 91 | 17,353 63 | 240,274 28 |
| Maintenance and operation of works: — | | | | |
| Wachusett Aqueduct, | $280 51 | | $3,750 87 | |
| Wachusett Reservoir, | 4,223 85 | | 14,522 14 | |
| Sudbury system, | 2,513 58 | | 10,010 89 | |
| Distribution system, | 1,296 48 | | 8,470 93 | |
| Clinton sewerage system, | 513 33 | 8,827 75 | 3,190 44 | 39,945 27 |
| Total receipts, | | $38,085 85 | | $500,306 21 |

## (c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

## (d) *Liabilities.*

There are liabilities as follows: —

| | |
|---|---|
| Current bills unpaid, | $8,319 87 |
| Due on monthly pay rolls, | 1,998 94 |
| | $10,318 81 |

***Amounts reserved on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.***

| Name. | Work. | Amount. |
|---|---|---|
| C. A. Dodge & Co., | Arlington pumping station, | $1,974 78 |
| A. McKenzie & Co., | Sterling filter-beds, | 1,233 54 |
| | | $3,208 32 |

Amounts have been agreed upon in the following cases, but the deeds have not yet passed: —

Martha E. Prescott, estate of, $425; Charles F. C. Henderson, $800; West Boylston, town of, $3,100.

On the claims of the following it is impossible to state the amounts due for land damages, water rights and claims for damages to established business, as no sums have been agreed upon, and suits are now pending in the court for the determination of most of them: —

Eliza M. Childs *et al.*, Charles J. Paine, Benjamin H. Clemmons, Edward Dooley, Charles C. Landy, Alfred N. Whiting, Houghton Bros., Robert Johnson, John F. O'Brien, Patrick Bradley, Thomas H. Burgess, Margaret F. Tonry, Lucy A. Wood, Joseph O. Bullard *et al.*, Elwin I. Chase, Alzina A. Wilson, Henry F. Keyes, Robert C. Houghton *et al.*, John Burns, Patrick Daly, Rebecca T. Farr, Annie L. Gibbons, Francis Gibbons, John Gibbons, Henry Wilson Co-operative Bank, Mary J. Hensby, William E. Keating, Millard E. Lewis, Middlesex Fells Springs Company, Lillian F. Pullen *et al.*, William E. Sprague, James E. Welch, Caroline E. Tyson, John E. Stone, Bridget M. Joyce, Israel L. Barnes *et al.*, William L. Bancroft, George H. Chase, Andrew L. Nourse, Byron D. Allen, J. Frank Wood *et al.*, Jennie L. Goodnow, Asa Knight, Worcester County Truant School, James H. Atherton, J. Quincy Dix, John E. Farnsworth, Mary J. Fyfe, estate of William E. Fyfe, Lizzie M. Gray, William B. Haskell, Henry F. Haynes, Sarah G. Haynes, Eben C. Mann, George M. Plummer, Howard D. Stone, Luther Willard, Samuel F. Mason, Edward F. Merriam, Henrietta M. Andrews, James A. Bigelow, First Parish of Boylston, William H. Brigham, John Fitzgerald, estate of Augustus Flagg, Mary J. Hastings, executrix, George R. Hastings, William H. Hastings, Henry J. Hyde, Everett and Oliver S. Kendall, Sanford C. Kendall, William C. Rosenthal, Jennie W. Taylor, administratrix, estate of William H. Vickery, James H. and Hannah S. Wood, Asenath M. Bartlett, estate of Charles I. Longley, estate of Daniel M. Marsh, Henry B. Stone, Francis W. M. Goodale, John S. Ott, McArthur Bros. Company, Helen M. Houghton *et al.*, Sarah Hourty, Clara L. Kingsbury, Willie R. Mitchell, Charles O. Nixon, Margaret Lane, George W. Shattuck, George F. Bond.

Construction of Sewer Trench in Thickly Settled Part of Malden for Extension of North Metropolitan Sewer.

## VI. METROPOLITAN SEWERAGE WORKS.

The Metropolitan Sewerage Works are divided into two systems, the North Metropolitan System and the South Metropolitan System. No change has been made in the territory contributing to these systems during the past year.

The North Metropolitan System provides for the district situated largely in the Charles River and Mystic River valleys lying north of the Charles River, and embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville, Woburn and parts of Boston, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester, Winthrop and part of Lexington, 9 cities and 8 towns. The district has an area of 90.50 square miles. It has an estimated population, as of December 31, 1906, based upon the census of 1905, of 488,663; and it is estimated that of this number 386,343, or 79.1 per cent., contribute sewage to the North Metropolitan System.

The South Metropolitan System provides for the areas situated in the Charles River valley lying south of the Charles River, a small portion of the valley north of the Charles River, and also a portion of the Neponset River valley, and embraces the cities of Newton, Quincy, Waltham and portions of Boston, and the towns of Brookline, Hyde Park, Milton, Watertown and part of Dedham, — 4 cities and 5 towns. This district has an area of 100.87 square miles. It has an estimated population, as of December 31, 1906, of 312,380, of which number it is estimated that 167,070, or 53.5 per cent., contribute sewage to the South Metropolitan System.

### (1) North Metropolitan Sewerage System — Construction.

By chapter 319 of the Acts of the Legislature of the year 1906, the Board was authorized to extend the North Metropolitan System by the construction of a main sewer from a point near the centre of the city of Malden, near what is known as Barrett's Pond, to the tidal meadows on the southerly borders of the city, where an efficient overflow into the waters of the Malden River is to be found.

When the town of Wakefield was added to the North Metropolitan System, a new trunk line was built between the boundary of that town and the city of Melrose to the centre of the city of Malden; but from this point the original Metropolitan Sewer was estimated to

have a carrying capacity sufficient for both the original line and the new line for a considerable number of years. The time, however, had come when the original Metropolitan Sewer was inadequate to carry away the contents of both sewers.

A contract was made and work was begun for the construction of this sewer in the middle of August, 1906, and the entire work was substantially completed near the end of December. The length of the extension is 2,950.5 feet, and it is built with a diameter varying from about 2.5 feet to 4.5 feet.

Of the entire length of 2,950.5 feet, 608 feet were constructed in private land and 2,342.5 feet through streets and ways.

The expenditures for construction have amounted to $47,369.74, and in addition the damages on account of the taking of real estate have amounted to $2,000. But a small amount of bills or claims remain to be settled.

## (2) South Metropolitan System — Construction.

### (a) *Extension of the High-level Sewer.*

The Board was instructed by chapter 406 of the Acts of the year 1906 to construct an extension of the High-level Sewer from the corner of Centre and Perkins streets in Jamaica Plain through West Roxbury, Brookline and as far as Oak Square in Brighton, substantially as outlined in the Fourth Annual Report made for the year 1904. The Board had submitted in its report for that year a general plan for the construction of the High-level extension from the junction with the sewer already constructed to the point mentioned in Brighton, and thence further into and through the city of Newton to a point near the Charles River at the village of Newton Lower Falls. The instruction of the Legislature was for the building of that portion of the sewer for which the need had already arisen. The Act was passed near the end of May.

The Board at once upon the passage of the Act began the making of detailed plans for the construction of this extension, and for convenience the length of 5.6 miles from West Roxbury to Oak Square in Brighton was divided into sections numbering consecutively from 80 to 86 inclusive. Specifications were also prepared for the building of the portions of the sewer which, as was anticipated, would require the longest periods of time.

The first section, No. 80, in West Roxbury, extending as far as

the Brookline town line, has a length of about 4,500 feet. It was anticipated that the building of this section would be more difficult, because it extends for a part of the distance through quicksands, gravel and clay, and for a portion of the distance is to extend near Jamaica Pond, where the bottom of the tunnel will be about 35 feet below the usual water surface of the pond. It was deemed necessary to carry on the work of building the tunnel by pneumatic processes, and it was accordingly determined to construct this section by day labor, under the immediate direction of a tried expert. Active work was begun at the beginning of October in building a circular shaft 70 feet in depth. After the completion of the shaft the work of tunneling from headings in both directions was begun, and at the end of the year successful progress to the extent of about 134 feet of tunnel had been made.

Near the end of the year bids were asked for the construction of a section to be known as No. 85, which consisted in the building of a tunnel through Commonwealth Avenue and other streets in the Brighton district, to be constructed largely in rock excavation. The bids offered for the construction of this part of the sewer were so largely in excess of the estimates of cost made by the Engineer that it was finally determined to proceed in the construction of a portion of the section by day labor. At the end of the year preparations were in progress for the immediate beginning of the work.

(*b*) *Connection with Portion of Charles River Valley Sewer.*

At the date of the last report a small portion of the Charles River valley sewer, below the point in Vancouver Street where this sewer was connected with the Ward Street pumping station, and extending for a distance of about 1,800 feet to Gainsborough Street, was, by arrangement with the city of Boston, still connected with the Boston Main Drainage Works. The work of changing the grade of this portion of the old sewer, so that the sewage would be made to run in the opposite direction to the Ward Street station and thence be disposed of in the High-level Sewer, was in progress. This work was completed in March of the past year, and thereafter all the sewage from the areas in the city of Boston tributary to this portion was diverted and disposed of in the High-level Sewer. All the necessary work was performed by men belonging to the regular maintenance force.

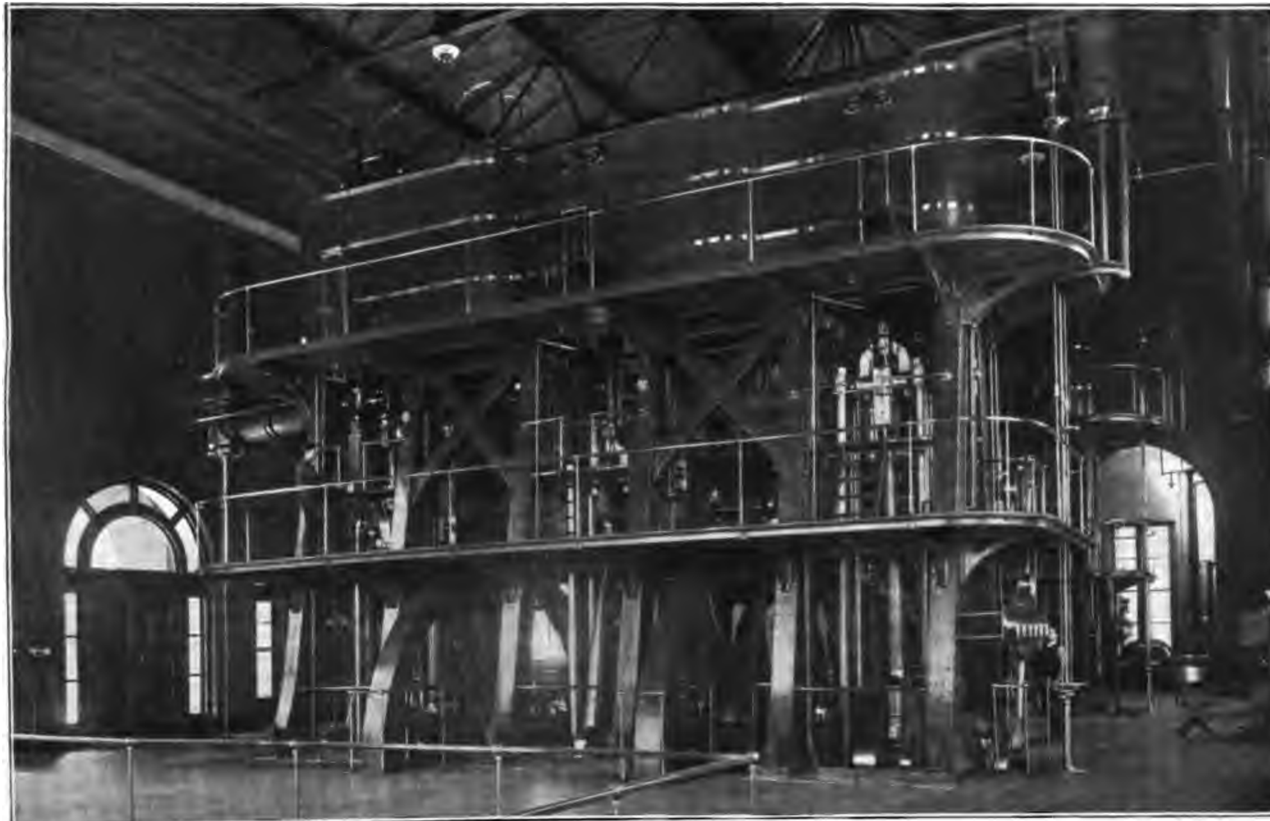
### (c) *Ward Street Pumping Station.*

The two pumping engines for raising the sewage from the Charles River valley sewerage district to the High-level Sewer had been previously installed in the pumping station, and had been for a considerable period in operation prior to the past year. Some modifications, however, in order to bring them to the contract requirements, had been in progress, and consequently the final test of the engines had not been made. By the requirements of the contract the engines were to have a capacity each for pumping 50,000,000 gallons of sewage per day, raising the sewage about 40 feet. The various changes were completed in the latter part of the year, the final tests were made successfully, and both engines were accepted. The engines are of the vertical triple expansion type with pump plungers directly under the steam cylinders, were especially designed for pumping sewage, and were furnished by the Allis-Chalmers Company of Milwaukee, Wis. The total cost was $204,000.

During the year granolithic walks have been built around and in the pumping station lot, and fences have been erected along Ward Street and Vancouver Street and upon the north side of the lot. The laying of the walks and the building of the fences have been performed from time to time by the day-labor men upon the maintenance force at times when they could be conveniently withdrawn from regular maintenance work.

### (d) *Quincy Pumping Station.*

The ordinary flow of sewage at the Quincy pumping station had so increased as to exceed the capacity of the smaller of the two pumps in use, and during the wet weather the flow had exceeded for considerable periods the capacity of both the pumps. It was therefore necessary to obtain, both in order to provide for the exigency in ordinary periods and also to prevent overflow in wet weather, an additional pumping plant. A centrifugal pump was purchased from the Lawrence Machine Company of Lawrence, Mass., and was installed with a compound Sturtevant engine, both pump and engine being of a standard type. Two additional boilers have also been introduced. The pump, engine and boilers have all been put in place, and it is anticipated that the new plant will be completed so as to be put into operation in the coming spring.



INTERIOR OF WARD STREET SEWERAGE PUMPING STATION WITH PUMPING ENGINES.

### (3) Acquisition of Lands and Settlements for Lands Acquired.

During the year there have been made 4 takings of land and easements, 3 of which were for the purposes of the extension of the High-level Sewer in West Roxbury and Brighton, and 1 for the purposes of the extension of the North Metropolitan Sewer in Malden. These takings embrace 0.018 of an acre in fee, temporary rights in 0.25 of an acre and easements in 20.432 acres, of which 3.48 acres were in public streets.

The following is a list of the takings: —

*List of Takings for Metropolitan Sewerage Works for the Year 1906.*

| No. | Location and Description. | Former Owners. | Recorded. | Purpose of Taking. |
|---|---|---|---|---|
| | | | 1906. | |
| 12 | Malden (from a short distance north of Waverly Street, southerly through Linden Avenue, Pleasant Street and private lands to North Metropolitan Sewer, about 500 feet south of Charles Street). Area, 0.018 of an acre in fee and easements in 2.136 acres. | Alonzo A. West and others, and streets. | Aug. 11. | Section 64, Malden extension, North Metropolitan System. |
| 13 | Jamaica Plain (from the westerly end of strip in which easements were taken for the Metropolitan Sewer in Perkins Street, a short distance west of Centre Street, westerly through Perkins Street and Chestnut Street to the Brookline boundary line). Area, easements in 3.48 acres. | Public streets. | Sept. 6. | Section 80, extension of High-level Sewer, South Metropolitan System. |
| 14 | Jamaica Plain (on northerly side of Perkins Street, between South Huntington Avenue and Jamaicaway). Area, temporary rights in 0.25 of an acre. | Edward J. Donovan *et al.*, trustees. | Sept. 24. | Section 80, extension of High-level Sewer, South Metropolitan System. |
| 15 | Brighton (from Brookline line, through Harlan Street, Commonwealth Avenue, Warren Street, Cambridge Street and Washington Street, to head of Lake Street). Area, easements in 14.816 acres. | Trustees of Crescent Land Company, devisees of Otis Shepard, and public streets. | Dec. 29. | Part of Section 84 and Section 85, High-level Sewer, South Metropolitan System. |

Since January 1, 1906, settlements have been effected on account of the takings made in the North Metropolitan District in 2 cases, involving a payment of $2,000; and in cases in the South Metropolitan District 1 settlement has been effected, under which payment has been made amounting to $4,589.66.

Of the 3 sewerage settlements, 2 were on account of the sewer extension to Malden and 1 on account of the Neponset valley sewer in the city of Boston, West Roxbury District.

*Summary of Land Settlements for the Year 1906.*

| Location. | Area in Acres. | Number of Settlements. | Payments. |
|---|---|---|---|
| *North Metropolitan District.* | | | |
| Malden, | 0.218 | 2 | $2,000 00 |
| *South Metropolitan District.* | | | |
| Boston, West Roxbury District, | 0.506 | 1 | 4,589 66 |
| Aggregate, | 0.724 | 3 | $6,589 66 |

(4) North Metropolitan System — Maintenance.

There are maintained in the North Metropolitan System 58.566 miles of main sewers, with which are connected 593.88 miles of local sewers, the number of connections, public and special, with the North Metropolitan System being 620.

The East Boston and Charlestown districts of Boston and the cities of Everett, Cambridge, Somerville and Chelsea still maintain both separate and combined sewers, and no decided gain seems to have been made in any of these municipalities during the year towards the further separation of sewers. All of the other municipalities in the North Metropolitan System maintain separate sewers.

The four pumping stations maintained for this system are the Alewife Brook pumping station at Somerville, the East Boston pumping station, the Charlestown pumping station and the Deer Island pumping station.

There have been pumped at the Alewife Brook pumping station 3,451,000 gallons of sewage per day, with an average lift of 13.08 feet, at a cost of $0.326 per million gallons per foot lifted; at the Charlestown station 30,500,000 gallons per day, 8.26 feet lift, at a cost of $0.142 per million gallons per foot lifted; at the East Boston station 56,100,000 gallons per day, 16.59 feet lift, at a cost of $0.064 per million gallons per foot lifted; and at the Deer Island station 58,100,000 gallons per day, 10.66 feet lift, at a cost of $0.089 per million gallons lifted. The cost of pumping per million gallons, notwithstanding the increased cost of labor, has remained about the same as last year, this cost having been slightly increased in two of the stations and decreased in the remaining two stations.

There has been a decided increase in the amount of sewage pumped in the different stations. The total quantity of sewage discharged at the outlet in Boston harbor, which is represented by the number of gallons of sewage pumped at the Deer Island station, was 58,100,000 gallons per day, which is 3,700,000 gallons in excess of the discharge at the outlet the preceding year.

The amount of sewage discharged in the North Metropolitan District averaged 150 gallons per day for each person, taking the estimated population of the District contributing sewage. Owing, however, to the fact that many of the sewers are combined sewers, this amount represents a considerable quantity of rain water received in the sewers, and would be considerably decreased if all the local sewers were separate sewers, that is, restricted to the admission of sewage proper only.

During the year 5 public and 32 special connections with local sewers have been made, — a total addition of 20.31 miles of connecting sewers.

The salt-water pipes laid from the East Boston pumping station upon the muddy bed of the Chelsea Creek for the purpose of supplying the condensers of the station had been constantly covered with silt from the changing character of the bed, and frequent removal of the silt had caused constant expense. It was consequently determined to lay a large pipe upon pile supports over the bed of the creek, to the channel where the mouth of the pipe is carried, so low as to remain submerged under all conditions.

Although the extension of the main sewer, which receives the sewage of the town of Wakefield, from a point near the centre of the city of Malden to tide water, has been completed, this extension had not been put into operation at the end of the year.

The cost of maintenance of the North Metropolitan System during the past year was $115,196.33, which is slightly less than the cost of maintenance for the preceding year.

### (5) South Metropolitan System — Maintenance.

In the South Metropolitan System there are maintained 38.178 miles of main sewers, with which are connected 468.18 miles of local sewers having 106 connections with the Metropolitan System.

The Back Bay, Brighton and Dorchester districts of Boston and the towns of Brookline and Milton still maintain both separate and

combined sewers. All the other districts contributory to this system maintain separate sewers.

The Ward Street pumping station, the Quincy pumping station and the screen-house at Nut Island are maintained for the disposal of sewage for this system.

The Ward Street pumping station has been in regular operation during the entire year, although the pumping engines had not been finally accepted from the contractors until near the end of the year.

There have been pumped at the Ward Street station an average of 24,500,000 gallons per day, with an average lift of 40.65 feet, at a cost of $0.068 per million gallons per foot lifted; and at the Quincy station 3,528,000 gallons, 21.25 feet lift, at an average cost of $0.226 per million gallons per foot lifted.

An average of 33,600,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum discharge per day, which occurred during a heavy storm, was 97,000,000 gallons. The discharge of sewage through the outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 201 gallons per day per person of the estimated number contributing sewage in the District. The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size of the High-level Sewer, more storm water is admitted at periods of heavy rainfall.

An additional pumping engine has been obtained for the Quincy station and will be put into operation at the beginning of the year, so that the station will soon be relieved from the troubles which have occurred particularly in periods of unusual rainfalls.

Subsequent to the month of March, when the necessary changes had been completed by which the sewage from the Huntington Avenue section of the Charles River valley sewer was raised into the High-level Sewer, the entire Charles River valley sewage has been disposed of by the Metropolitan Works, so that thereafter no further rental on this account was payable to the city of Boston for the disposal of sewage. A small area in the district of Dorchester and town of Milton, which is so low that its sewage cannot be carried into the High-level Sewer except by pumping, still disposes

of its sewage through the Boston Main Drainage Works, and for this a rental is paid to the city of Boston.

The strong tidal currents were found to have caused considerable wearing away of the clay filling of the pipe trenches of the great outfall pipes of the High-level Sewer laid in the harbor off Nut Island. Accordingly it was deemed necessary to lay about 170 cubic yards of small riprap over the pipes in place of the clay washed away. This work was done by a diving contractor. No deposit of the sewage discharge was found remaining about the outlet of the pipes, and for a considerable distance the pipes were entered and found in good condition.

The expenditures for maintenance of the South Metropolitan System for the past year were $82,190.61.

## VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the eleven months of the fiscal year of the Commonwealth ending with the thirtieth day of November, 1906, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is printed as Appendix No. 5.

The following detailed statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1906, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan sewerage loans for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,160,865.73, to which are added receipts from various sources amounting to $17,153.40. The amount of expenditures approved by the Board for payment for the year 1906 was $47,369.74, and the total amount of expenditures approved to January 1, 1907, was $6,136,200.30. The balance on hand January 1, 1907, was $41,818.83.

The loans for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $6,878.47. The amount of

expenditures approved for payment in the year 1906 was $98,730.49. The total amount of expenditures approved for payment from the beginning of the works has been $7,722,773.15. The balance on hand for the South Metropolitan System on January 1, 1907, was $1,151,151.59.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds on the North Metropolitan System have amounted to $175,518.65, and those received on account of the South Metropolitan System have amounted to $394,133.13.

The amount expended for maintenance of the North Metropolitan System in the year 1906 was $115,196.33, and for the South Metropolitan System $82,190.61, a total for both systems of $197,386.94.

The assessments made to meet interest, sinking fund requirements, and maintenance and operation of the North Metropolitan System amounted in the year 1906 to $355,538.73, and the assessments for the South Metropolitan System amounted to $397,322.44.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

## (1) Metropolitan Sewerage Loans, Receipts and Payments.

The loans for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows: —

### (a) *North Metropolitan System.*

| | |
|---|---|
| Loans under various acts of the Legislature (given in detail in report for the year 1901), | $5,605,865 73 |
| Loans under chapters 242, 336 and 399, Acts of 1903, | 500,000 00 |
| Loan under chapter 319, Acts of 1906, | 55,000 00 |
| Proceeds from sales of property and from other sources to December 31, 1906, | 17,153 40 |
| | $6,178,019 13 |
| Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1906 (of which $47,369.74 is for the year 1906), | 6,136,200 30 |
| Balance, North Metropolitan System, January 1, 1907, | $41,818 83 |

### (b) *South Metropolitan System.*

| | |
|---|---|
| Loans under the Acts of the years 1889 and 1900 (Charles River Valley Sewer), | $800,046 27 |
| Loans under various acts of the Legislature (given in detail in report for the year 1901, Neponset River Valley Sewer), | 900,000 00 |
| Loan under chapter 315 of the Acts of 1903 (Neponset River Valley Sewer), | 4,000 00 |
| Loan under chapter 424 of the Acts of 1899, | 4,600,000 00 |
| Loan under chapter 356 of the Acts of 1903, | 996,000 00 |
| Loans under chapters 230 and 246 of the Acts of 1904, | 392,000 00 |
| Loan under chapter 406 of the Acts of 1906, | 1,175,000 00 |
| Proceeds from sales of property and other sources to December 31, 1906 (of which $256.20 is for the year 1906), | 6,878 47 |
| | $8,873,924 74 |
| Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1906 (of which $98,730.49 is for the year 1906), | 7,722,773 15 |
| Balance, South Metropolitan System, January 1, 1907, | $1,151,151 59 |

### (2) Issues of Metropolitan Sewerage Loan Bonds.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," as follows: —

#### Metropolitan Sewer Loans, North System.

*Bonds issued.*

| Date of Sale. | Amount of Bonds sold. | Rate of Interest (per cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Apr. 2, 1890, | $500,000 | 3 | 102.40 | Jan. 1, 1930, | $12,000 00 |
| Apr. 2, 1890, | 500,000 | 3 | 103.02 | Jan. 1, 1930, | 15,100 00 |
| Apr. 2, 1890, | 500,000 | 3 | 103.62 | Jan. 1, 1930, | 18,100 00 |
| Apr. 2, 1890, | 500,000 | 3 | 102.327 | Jan. 1, 1930, | 11,635 00 |
| Apr., 1890, | 200,000 | 3 | 103. | Jan. 1, 1930, | 6,000 00 |
| Feb., 1891, | 50,000 | 3 | 104. | Jan. 1, 1930, | |
| Mar., 1891, | 300,000 | 3 | 104. | Jan. 1, 1930, | 35,130 30[1] |
| Mar., 1891, | 18,000 | 3 | 104. | Jan. 1, 1930, | |
| Jan., 1892, | 35,000 | 3 | 100. | Jan. 1, 1930, | - |
| Feb., 1892, | 29,000 | 3 | 100. | Jan. 1, 1930, | - |
| Mar., 1892, | 50,000 | 3 | 101. | Jan. 1, 1930, | 500 00 |
| June, 1892, | 436,000 | 3 | 101.50 | Jan. 1, 1930, | |
| July, 1892, | 150,000 | 3 | 101.50 | Jan. 1, 1930, | 11,060 00[1] |
| Aug., 1892, | 150,000 | 3 | 101.50 | Jan. 1, 1930, | |

[1] Readjustment of Treasurer.

## Metropolitan Sewer Loans, North System — *Concluded.*

*Bonds issued* — Concluded.

| Date of Sale. | Amount of Bonds sold. | Rate of Interest (per cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Nov., 1892, . . . . . . . | $3,000 | 3 | 100.50 | Jan. 1, 1930, | $15 00 |
| Nov., 1892, . . . . . . . | 200,000 | 3 | 100. | Jan. 1, 1930, | - |
| Jan., 1893, . . . . . . . | 35,000 | 3 | 100.50 | Jan. 1, 1930, | 175 00 |
| Jan., 1893, . . . . . . . | 25,000 | 3 | 100.50 | Jan. 1, 1930, | 125 00 |
| Feb., 1893, . . . . . . . | 20,000 | 3 | 101. | Jan. 1, 1930, | 200 00 |
| Feb., 1893, . . . . . . . | 5,000 | 3 | 100.50 | Jan. 1, 1930, | 25 00 |
| Feb., 1893, . . . . . . . | 400,000 | 3 | 100.25 | Jan. 1, 1930, | 1,000 00 |
| Mar., 1893, . . . . . . . | 94,000 | 3 | 100.25 | Jan. 1, 1930, | 235 00 |
| May 1, 1894, . . . . . . . | 464,000 | 3 | 100. | Jan. 1, 1930, | - |
| Oct., 1894, . . . . . . . | 4,000 | 3 | 100. | Jan. 1, 1930, | - |
| Oct., 1894, . . . . . . . | 1,000 | 3 | 100. | Jan. 1, 1930, | - |
| Nov., 1894, . . . . . . . | 15,000 | 3 | 100. | Jan. 1, 1930, | - |
| Nov., 1894, . . . . . . . | 10,000 | 3 | 100. | Jan. 1, 1930, | - |
| Dec., 1894, . . . . . . . | 6,000 | 3 | 100. | Jan. 1, 1930, | - |
| Apr., 1895, . . . . . . . | 300,000 | 3 | 100. | Jan. 1, 1930, | - |
| Dec., 1896, . . . . . . . | 30,000 | 3 | 100. | Jan. 1, 1930, | - |
| June, 1897, . . . . . . . | 70,000 | 3½ | 106.243 | Jan. 1, 1930, | 5,084 80[1] |
| June, 1897, . . . . . . . | 10,000 | 3½ | 106.243 | Jan. 1, 1930, | |
| Apr., 1898, . . . . . . . | 5,000 | 3 | 100. | Jan. 1, 1930, | |
| June, 1898, . . . . . . . | 155,000 | 3½ | 100. | Jan. 1, 1930, | 22,843 75[1] |
| June, 1898, . . . . . . . | 60,000 | 3½ | 100. | Jan. 1, 1930, | |
| Apr., 1900, . . . . . . . | 265,000 | 3 | 103.948 | Jan. 1, 1930, | 10,462 20 |
| May, 1903, . . . . . . . | 200,000 | 3½ | 104.9797 | Jan. 1, 1930, | 9,959 40 |
| May, 1903, . . . . . . . | 50,000 | 3½ | 106.2424 | Jan. 1, 1943, | 3,121 20 |
| July, 1903, . . . . . . . | 250,000 | 3½ | 104.419 | July 1, 1943, | 11,047 50 |
| June, 1906, . . . . . . . | 55,000 | 3½ | 103.09 | July 1, 1943, | 1,699 50 |
| | $6,150,000 | | | | $175,518 65 |

[1] Readjustment of Treasurer.

## Metropolitan Sewer Loans, South System.

*Bonds issued.*

| Date of Sale. | Amount of Bonds sold. | Rate of Interest (per cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Apr., 1890, . . . . . . . | $100,000 | 3 | 103. | Jan. 1, 1930, | $3,000 00 |
| Apr., 1890, . . . . . . . | 400,000 | 3 | 103. | Jan. 1, 1930, | 12,000 00 |
| May, 1890, . . . . . . . | 300,000 | 3 | 104. | Jan. 1, 1930, | 12,000 00 |
| Aug., 1895, . . . . . . . | 300,000 | 3 | 100.585 | Mar. 1, 1935, | 1,755 00 |
| Feb., 1896, . . . . . . . | 50,000 | 3 | 100. | Mar. 1, 1935, | - |
| Dec., 1896, . . . . . . . | 135,000 | 3 | 100. | Mar. 1, 1935, | - |
| Dec , 1896, . . . . . . . | 15,000 | 3 | 100. | Mar. 1, 1935, | - |
| June, 1897, . . . . . . . | 300,000 | 3½ | 106.98 | Mar. 1, 1935, | 20,940 00 |

### Metropolitan Sewer Loans, South System — *Concluded.*

*Bonds issued* — Concluded.

| Date of Sale. | Amount of Bonds sold. | Rate of Interest (per cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| June, 1898, | $35,000 | 3½ | 100. | Mar. 1, 1935, | $4,088 00[1] |
| June, 1899, | 25,000 | 3 | 100.64 | Mar. 1, 1936, | 160 00 |
| June, 1899, | 1,000,000 | 3 | 100.64 | July 1, 1939, | 6,400 00 |
| Sept., 1900, | 10,000 | 3 | 100.79 | July 1, 1939, | 79 00 |
| Sept., 1900, | 912 | 3 | 100. | July 1, 1939, | - |
| Apr., 1901, | 40,000 | 3 | 100.915 | Mar. 1, 1936, | 366 00 |
| Sept., 1901, | 2,000,000 | 3½ | 106.71 | July 1, 1940, | 134,200 00 |
| Sept., 1902, | 14,000 | 3 | 100. | July 1, 1939, | - |
| Sept., 1902, | 500,000 | 3½ | 107.243 | July 1, 1940, | 36,215 00 |
| Sept., 1902, | 150,000 | 3½ | 107.2395 | July 1, 1940, | 10,859 25 |
| Dec., 1902, | 200,000 | 3½ | 107.79 | July 1, 1940, | 15,580 00 |
| Feb., 1903, | 100,000 | 3½ | 108.25 | July 1, 1940, | 8,230 56[1] |
| Apr., 1903, | 100,000 | 3½ | 106.75 | July 1, 1940, | 6,750 00 |
| Apr., 1903, | 175,000 | 3½ | 106.75 | July 1, 1940, | 11,812 50 |
| Apr., 1903, | 203,000 | 3½ | 106.75 | July 1, 1940, | 13,702 50 |
| Apr., 1903, | 25,000 | 3½ | 106.494 | July 1, 1940, | 1,623 50 |
| Apr., 1903, | 133,000 | 3½ | 105.9364 | July 1, 1940, | 7,895 42 |
| May, 1903, | 996,000 | 3½ | 106.2424 | Jan. 1, 1943, | 62,174 31 |
| May, 1903, | 4,000 | 3½ | 105.5453 | Mar. 1, 1935, | 221 81 |
| July, 1904, | 392,000 | 3½ | 104.929 | July 1, 1944, | 19,321 68 |
| June, 1906, | 154,000 | 3½ | 103.09 | Jan. 1, 1946, | 4,758 60 |
| | $7,856,912 | | | | $394,133 13 |

[1] Readjustment of Treasurer.

### (3) Metropolitan Sewerage Loans Sinking Fund.

Under authority of chapter 122 of the Acts of 1899, and section 14 of chapter 424 of the Acts of 1899, the Treasurer of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan sewerage loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund. The Board received, during the year, from rentals and from other sources, to be applied to the sinking fund, $75.

The sinking fund established has amounted at the end of each year to sums as follows: —

| | | | |
|---|---|---|---|
| December 31, 1899, | $361,416 59 | December 31, 1903, | $754,690 41 |
| December 31, 1900, | 454,520 57 | December 31, 1904, | 878,557 12 |
| December 31, 1901, | 545,668 26 | December 31, 1905, | 1,008,724 95 |
| December 31, 1902, | 636,084 04 | December 31, 1906, | 1,146,998 68 |

### (4) Annual Appropriations, Receipts and Expenditures.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1906, have been as follows: —

*North Metropolitan System.*

| | |
|---|---|
| Balance January 1, 1906, | $32,897 15 |
| Appropriation under chapter 153 of the Acts of 1906, | 115,986 50 |
| Receipts from pumping and from other sources, | 1,013 43 |
| | $149,897 08 |
| Amount approved by the Board for payment, | 115,196 33 |
| Balance January 1, 1907, | $34,700 75 |

*South Metropolitan System.*

| | |
|---|---|
| Balance January 1, 1906, | $139 99 |
| Appropriation under chapter 154 of the Acts of 1906, | 87,375 00 |
| Receipts from sales of property, from pumping, and from other sources, | 51 50 |
| | $87,566 49 |
| Amount approved by the Board for payment, | 82,190 61 |
| Balance January 1, 1907, | $5,375 88 |

### (5) Annual Assessments.

Assessments for the year, amounting to $355,538.73 for the North Metropolitan System and to $397,322.44 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $188,299.64; for the sinking fund, $51,252.59; and for maintenance, $115,986.50. For the South Metropolitan System the requirements were: for interest, $263,281.72; for the sinking fund, $46,665.72; and for maintenance, $87,375. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906, and the assessments for the South Metropolitan System were made in accordance with ratios fixed by the Apportionment

Commissioners appointed under the provisions of chapter 424 of the Acts of the year 1899, and were as follows: —

*North Metropolitan Sewerage System.*

| | | | |
|---|---|---|---|
| Arlington, | $8,043 51 | Somerville, | $49,319 97 |
| Belmont, | 4,516 64 | Stoneham, | 4,404 90 |
| Boston, | 61,791 73 | Wakefield, | 7,140 26 |
| Cambridge, | 84,895 57 | Winchester, | 8,006 97 |
| Chelsea, | 22,722 35 | Winthrop, | 6,519 24 |
| Everett, | 18,823 32 | Woburn, | 9,813 86 |
| Lexington, | 3,072 26 | Revere, | 9,696 13 |
| Malden, | 27,531 28 | | |
| Medford, | 17,018 25 | Total, | $355,538 73 |
| Melrose, | 12,222 49 | | |

*South Metropolitan Sewerage System.*

| | | | |
|---|---|---|---|
| Boston, | $164,563 84 | Quincy, | $23,813 99 |
| Brookline, | 74,105 67 | Waltham, | 23,302 26 |
| Dedham, | 9,746 91 | Watertown, | 11,777 86 |
| Hyde Park, | 12,673 70 | | |
| Milton, | 18,965 22 | Total, | $397,322 44 |
| Newton, | 58,372 99 | | |

## (6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *North Metropolitan System.* | | | | |
| Original system, main line and branches, | - | | | $5,388,932 67 |
| Lexington branch, | - | | | 68,585 15 |
| Everett branch, | - | | | 54,877 12 |
| Wakefield branch, | - | | | 35,698 29 |
| Stoneham branch, | - | | | 11,574 10 |
| Chelsea and Everett outlets, | - | | | 71,216 41 |
| Belmont extension, | - | | | 57,153 06 |
| Malden extension: — | | | | |
| Administration, | $2,054 00 | | $2,054 00 | |
| Section 64, | 43,140 14 | | 43,140 14 | |
| Land takings, purchase and recording, | 2,164 60 | $47,358 74 | 2,164 60 | 47,358 74 |
| Revere extension, | | - | | 215,722 79 |
| Wakefield branch extension, | | 11 00 | | 190,081 97 |
| Total North Metropolitan System, | | $47,369 74 | | $6,136,200 30 |

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *South Metropolitan System.* | | | | |
| Charles River valley sewer, main line, . . | - | | | $800,046 27 |
| Neponset River valley sewer: — | | | | |
| Main line, . . . . . . . . . . | - | | $866,595 66 | |
| Brookline branch, . . . . . . . | $5,797 66 | $5,797 66 | 44,935 80 | $911,531 46 |
| High-level Sewer: — | | | | |
| Administration, . . . . . . . . | $2,247 01 | | $51,593 57 | |
| Apportionment commission, . . . . | - | | 2,000 00 | |
| Land takings, purchase and recording, . | 100 00 | | 355,374 82 | |
| Quincy force main, . . . . . . . | 15 08 | | 18,351 71 | |
| Quincy pumping station, . . . . . | 2,141 54 | | 2,141 54 | |
| Section 43, Quincy, . . . . . . . | - | | 411,749 22 | |
| Section 44, Quincy, . . . . . . . | - | | 299,543 47 | |
| Section 45, Quincy, . . . . . . . | - | | 76,139 36 | |
| Section 46, Quincy, . . . . . . . | - | | 62,551 26 | |
| Section 47, Quincy, . . . . . . . | - | | 109,786 58 | |
| Section 48, Quincy, . . . . . . . | - | | 295,319 29 | |
| Sections 48 and 49, embankments, Quincy, . | - | | 81,548 64 | |
| Section 49, Quincy, . . . . . . . | - | | 169,020 18 | |
| Section 50, Quincy, . . . . . . . | - | | 109,570 35 | |
| Section 51, Quincy, . . . . . . . | - | | 87,203 68 | |
| Section 52, Quincy, . . . . . . . | - | | 155,800 65 | |
| Section 53, Quincy, . . . . . . . | - | | 98,042 42 | |
| Section 54, Quincy, . . . . . . . | - | | 101,918 39 | |
| Section 55, Milton and Quincy, . . . | - | | 305,816 90 | |
| Section 56, Milton, . . . . . . . | - | | 105,736 94 | |
| Section 57, Milton, . . . . . . . | - | | 68,783 24 | |
| Section 58, Milton, . . . . . . . | - | | 94,089 72 | |
| Section 59, Milton, . . . . . . . | - | | 104,444 62 | |
| Section 60, Milton, . . . . . . . | - | | 60,796 18 | |
| Section 61, Milton, . . . . . . . | - | | 129,598 76 | |
| Section 62, Milton, . . . . . . . | - | | 129,612 28 | |
| Section 63, Milton, . . . . . . . | - | | 127,142 45 | |
| Section 64, Neponset River crossing, . . | - | | 47,554 40 | |
| Section 65, Hyde Park, . . . . . . | - | | 41,333 37 | |
| Section 66, Hyde Park, . . . . . . | - | | 253,902 72 | |
| Section 67, Hyde Park, Stony Brook crossing, | - | | 32,298 33 | |
| Section 68, Hyde Park and Roxbury, . . | - | | 78,498 62 | |
| Section 69, West Roxbury, . . . . . | - | | 102,143 68 | |
| Section 70, West Roxbury, . . . . . | - | | 131,375 55 | |
| Section 71, West Roxbury, . . . . . | - | | 91,888 22 | |
| Section 72, West Roxbury, . . . . . | - | | 127,956 76 | |
| Section 73, West Roxbury, . . . . . | - | | 494,290 42 | |
| Section 74, West Roxbury and Roxbury, . | - | | 147,296 60 | |
| Section 75, Roxbury, . . . . . . | - | | 137,192 99 | |
| Section 76, Roxbury, cast-iron force main, . | 62 75 | | 80,342 26 | |
| Section 77, Roxbury, Ward Street pumping station, . . . . . . . . . | 52,519 15 | | 555,258 47 | |
| Section 78, Roxbury, connecting sewer, . | - | | 35,994 60 | |
| Reversion of grade, Huntington Avenue, . | 6,047 49 | 63,133 02 | 6,503 56 | 5,977,501 90 |
| *Amounts carried forward*, . . . . | . . . | $68,930 68 | | $7,689,079 63 |

| Construction and Acquisition of Works. | For the Year ending December 31, 1906. | | From Beginning of Work to December 31, 1906. | |
|---|---|---|---|---|
| *Amounts brought forward,* | . . . | $68,930 68 | | $7,689,079 63 |
| *South Metropolitan System* — Con. | | | | |
| High-level extension: — | | | | |
| Charles River valley studies, | - | | $3,893 71 | |
| Entire line, | $11,326 37 | | 11,326 37 | |
| Section 80 (in part), West Roxbury, | 18,252 60 | | 18,252 60 | |
| Section 85, Brighton, | 220 84 | 29,799 81 | 220 84 | 33,693 52 |
| Total for South Metropolitan System, | . . . | $98,730 49 | | $7,722,773 15 |
| Total for construction for both systems, | . . . | $146,100 23 | | $13,858,973 45 |

| Maintenance. | For the Year ending December 31, 1906. | From Beginning of Work to December 31, 1906. |
|---|---|---|
| North Metropolitan System, | $115,196 33 | $1,127,975 80 |
| South Metropolitan System, | 82,190 61 | 1,018,546 94 |
| Total for maintenance, both systems, | $197,386 94 | $2,146,522 74 |

## (7) Detailed Financial Statement.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1906: —

### (a) *Expenditures and Disbursements.*

| General Character of Expenditures. | For the Year ending December 31, 1906. | |
|---|---|---|
| Construction of Works and Acquisition by Purchase or Taking. | | |
| *North Metropolitan System.* | | |
| Administration: — | | |
| Secretary, | $375 00 | |
| Clerks and stenographers, | 922 97 | |
| Stationery and printing, | 148 30 | |
| Telephone, lighting, heating, water and care of building, | 274 40 | |
| Rent and taxes, main office, | 333 33 | $2,054 00 |
| *Amount carried forward,* | . . . | $2,054 00 |

| General Character of Expenditures. | | For the Year ending December 31, 1906. | |
|---|---|---|---|
| *Amount brought forward,* | | . . . | $2,054 00 |
| *North Metropolitan System* — Con. | | | |
| Engineers, inspectors, rodmen, laborers and others, | | $4,735 21 | |
| Carriage hire and travelling expenses, | | 109 40 | |
| Advertising, | | 49 33 | |
| Office supplies, | | 18 36 | |
| Books, maps, plans and blue prints, | | 21 43 | |
| Engineering instruments and repairs of same, | | 82 75 | |
| Engineering supplies, | | 9 57 | |
| Tools and repairs of same, | | 95 | |
| Brick, cement, lumber and other field supplies, | | 1,939 36 | |
| Teaming and express, | | 10 50 | |
| Contracts: — | | | |
| T. H. Gill & Co., Section 64, | | 36,126 28 | |
| Land takings, purchase and recording, | | 2,164 60 | |
| Claims for damages, | | 48 00 | |
| | | | 45,315 74 |
| Total for North Metropolitan System, | | . . . | $47,369 74 |
| *South Metropolitan System.* | | | |
| *Neponset River Valley Sewer:* — | | | |
| Brookline branch: — | | | |
| Claims and allowances on account of contracts, | | $1,200 00 | |
| Land takings, purchase and recording, | | 4,597 66 | |
| | | | $5,797 66 |
| *High-level Sewer:* — | | | |
| Administration: — | | | |
| Secretary, | $750 00 | | |
| Clerks and stenographers, | 333 33 | | |
| Stationery and printing, | 165 84 | | |
| Postage, express and telegrams, | 35 00 | | |
| Telephone, lighting, heating, water and care of building, | 624 51 | | |
| Rent and taxes, main office, | 338 33 | | |
| | | $2,247 01 | |
| Chief engineer, | $1,250 00 | | |
| Engineers, inspectors, rodmen, laborers and others, | 20,831 25 | | |
| Advertising, | 95 88 | | |
| Carriage hire and travelling expenses, | 203 82 | | |
| Office supplies, | 48 21 | | |
| Postage, telephone and telegrams, | 46 89 | | |
| Books, maps, plans and blue prints, | 89 76 | | |
| Engineering instruments and repairs of same, | 39 02 | | |
| Engineering supplies, | 98 76 | | |
| Tools and repairs of same, | 269 46 | | |
| Brick, cement, lumber and other field supplies, | 16,252 77 | | |
| Teaming and express, | 220 00 | | |
| Repairs, fittings and supplies, main office, | 60 00 | | |
| Rent of sub-offices, | 80 00 | | |
| Contracts: — | | | |
| Allis-Chalmers Co., Section 77, | 51,000 00 | | |
| Land takings, purchase and recording, | 100 00 | | |
| | | 90,685 82 | |
| | | | 92,932 83 |
| Total for South Metropolitan System, | | . . . | $98,730 49 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | |
|---|---|---|
| **Maintenance and Operation of Works.** | | |
| *North Metropolitan System.* | | |
| Administration: — | | |
| Commissioners, secretary and assistants, | $3,498 34 | |
| Postage, printing, stationery and office supplies, | 540 03 | |
| Rent, telephone, heating, lighting and care of offices, | 952 12 | |
| Miscellaneous expenses, | 150 56 | |
| | | $5,141 05 |
| General superintendence: — | | |
| Engineer and assistants, | $7,862 41 | |
| Postage, printing, stationery and office supplies, | 671 64 | |
| Rent, telephone, heating, lighting and care of offices, | 968 79 | |
| Miscellaneous expenses, | 850 25 | |
| | | 10,353 09 |
| Deer Island pumping station: — | | |
| Labor, | $11,920 13 | |
| Coal, | 7,921 89 | |
| Oil and waste, | 322 57 | |
| Water, | 838 80 | |
| Packing, | 172 44 | |
| Repairs and renewals, | 1,962 41 | |
| Telephones and office supplies, | 178 59 | |
| Miscellaneous supplies and expenses, | 1,033 58 | |
| East Boston pumping station: — | | |
| Labor, | 11,119 86 | |
| Coal, | 9,318 70 | |
| Oil and waste, | 311 14 | |
| Water, | 1,270 80 | |
| Packing, | 109 60 | |
| Repairs and renewals, | 866 83 | |
| Telephones and office supplies, | 125 46 | |
| Miscellaneous supplies and expenses, | 1,023 54 | |
| Charlestown pumping station: — | | |
| Labor, | 10,758 05 | |
| Coal, | 2,891 32 | |
| Oil and waste, | 250 94 | |
| Water, | 364 80 | |
| Packing, | 107 78 | |
| Repairs and renewals, | 498 09 | |
| Telephones and office supplies, | 157 70 | |
| Miscellaneous supplies and expenses, | 330 50 | |
| Alewife Brook pumping station: — | | |
| Labor, | 4,358 44 | |
| Coal, | 1,578 45 | |
| Oil and waste, | 152 93 | |
| Water, | 162 60 | |
| Packing, | 56 67 | |
| Repairs and renewals, | 153 82 | |
| Telephones and office supplies, | 134 20 | |
| Miscellaneous supplies and expenses, | 84 60 | |
| | | 70,037 18 |
| *Amount carried forward,* | | $85,531 32 |

| General Character of Expenditures. | For the Year ending December 31, 1906. | |
|---|---|---|
| *Amount brought forward*, | . . . . | $85,531 32 |
| *North Metropolitan System* — Con. | | |
| Sewer lines, labor, | $23,009 20 | |
| Supplies and expenses, | 2,735 03 | |
| | | 25,744 23 |
| Horses, vehicles and stable account, | . . . . | 3,920 78 |
| Total, | . . . . | $115,196 33 |
| *South Metropolitan System.* | | |
| Administration: — | | |
| Commissioners, secretary and assistants, | $3,508 33 | |
| Postage, printing, stationery and office supplies, | 630 75 | |
| Rent, telephone, heating, lighting and care of building, | 553 33 | |
| Miscellaneous expenses, | 23 30 | |
| | | $4,715 71 |
| General superintendence: — | | |
| Engineer and assistants, | $2,853 33 | |
| Postage, printing, stationery and office supplies, | 309 21 | |
| Rent, telephone, heating, lighting and care of offices, | 643 79 | |
| Miscellaneous expenses, | 505 30 | |
| | | 4,311 63 |
| Ward Street pumping station: — | | |
| Labor, | $14,133 64 | |
| Coal, | 6,781 40 | |
| Oil and waste, | 865 54 | |
| Water, | 1,298 60 | |
| Packing, | 747 28 | |
| Repairs and renewals, | 23 49 | |
| Telephones and office supplies, | 167 92 | |
| Miscellaneous supplies and expenses, | 2,114 95 | |
| Quincy pumping station: — | | |
| Labor, | 4,799 37 | |
| Coal, | 1,647 87 | |
| Oil and waste, | 34 27 | |
| Water, | 193 56 | |
| Packing, | 9 40 | |
| Telephones and office supplies, | 39 82 | |
| Miscellaneous supplies and expenses, | 552 40 | |
| Nut Island screen-house: — | | |
| Labor, | 5,226 97 | |
| Coal, | 1,510 00 | |
| Oil and waste, | 47 54 | |
| Water, | 290 24 | |
| Packing, | 11 66 | |
| Repairs and renewals, | 22 | |
| Telephones and office supplies, | 83 27 | |
| Miscellaneous supplies and expenses, | 657 40 | |
| | | 41,231 81 |
| Sewer lines, labor, | $17,444 10 | |
| Supplies and expenses, | 2,423 55 | |
| | | 19,867 65 |
| City of Boston, for pumping and interest, | . . . . | 9,507 95 |
| Horses, vehicles and stable account, | . . . . | 2,555 86 |
| Total, | . . . . | $82,190 61 |

### (b) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

| Account. | For Year ending December 31, 1906. | From Beginning of Work to December 31, 1906. |
| --- | --- | --- |
| North Metropolitan System, — construction, | - | $17,153 40 |
| South Metropolitan System, — construction, | $256 20 | 6,878 47 |
| North Metropolitan System, — maintenance, | 1,018 43 | 8,189 96 |
| South Metropolitan System, — maintenance, | 51 50 | 1,078 93 |
| Metropolitan Sewerage Loans Sinking Fund, | 75 00 | 910 20 |
| Totals, | $1,396 13 | $34,210 96 |

### (c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

### (d) *Liabilities.*

There are liabilities as follows: —

| | |
| --- | --- |
| Current bills unpaid, | $20,292 47 |
| Due on monthly pay rolls, | 1,206 06 |
| | $21,498 53 |

*Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.*

| Name. | Work. | Amount. |
| --- | --- | --- |
| High-level Sewer: — | | |
| National Contracting Co., | Sect. 73, contract abandoned, | $5,516 17 |
| E. W. Everson & Co., | Sect. 75, | 1,000 00 |
| North Metropolitan Construction: — | | |
| T. H. Gill & Co., | Sect. 64, | 4,022 29 |
| | | $10,538 46 |

On the claims of the following it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

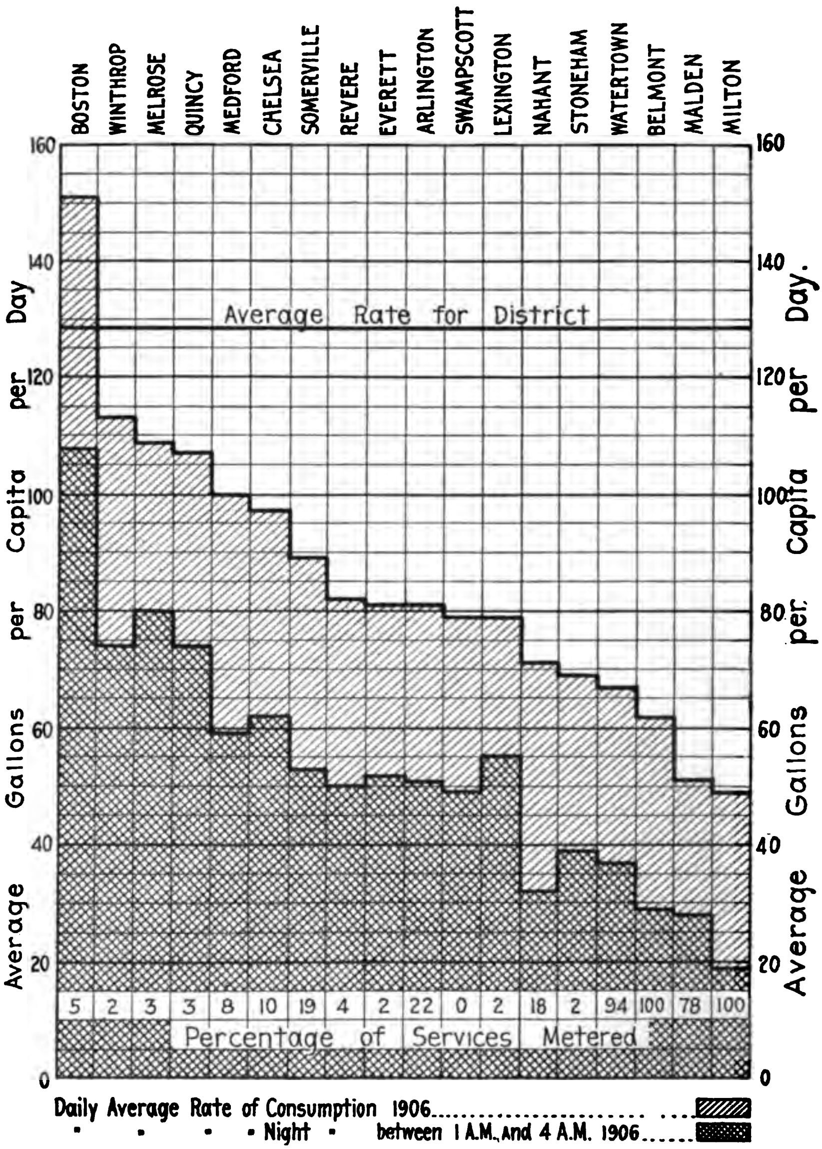
Boston Elevated Railway Company, Boston & Maine Railroad, Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Mary Doherty, Mary E. Doherty, Richard Jones, James Doherty, Michael Niland, Alonzo A. West, James Fitzpatrick, Michael Cashman, William H. Gibbons, Francis Normile.

## VIII. CONSUMPTION OF WATER.

The average daily quantity of water consumed by the cities and towns supplied by the Metropolitan Water Works during the year, as delivered from the various sources of supply, was 118,820,000 gallons, this being but a slight increase over the number of gallons per day so supplied in the preceding year. The consumption during the year so measured was 130 gallons per inhabitant per day, as against 131.2 gallons in the preceding year. There was an increase in the total quantity consumed in 9 of the municipalities, and in 9 there was a decrease. The change, however, in consumption was not especially noticeable except in the district of West Roxbury, in which there was a large reduction, owing to the discovery of leakages in the local pipes. This reduction in the West Roxbury district of Boston was due to the inspection made by the water officials of that city, who discovered and repaired a break in a 12-inch pipe, together with two other defects in service pipes and numerous others in house plumbing. The break in the main pipe was causing a waste of 108,000 gallons per day, which ran into an old well and disappeared. The reduction made by the discovery and repair of these defects amounted to about 25 per cent. of the total consumption of the District.

The consumption of water during the colder season still continues to increase according to the fall of the temperature. This, of course, is due to the fact that the water on many of the premises is allowed to run continuously in the coldest season in order to avoid the freezing of the pipes, and also that there are at this season many breakages, due to bad plumbing. In certain days of the winter the daily consumption reached 136,000,000 gallons. The great waste is especially shown by the consumption of water which occurs

DIAGRAM SHOWING
AVERAGE RATES OF CONSUMPTION OF WATER
IN THE METROPOLITAN DISTRICT IN 1906
DURING THE ENTIRE DAY AND DURING
THE HOURS OF 1 AND 4 AT NIGHT



between the hours of 1 and 4 in the morning, when only a very small quantity can be used for any legitimate purposes. The consumption between these hours reached a point as high as the rate of 105,000,000 gallons per day during some of the coldest weather, and at several periods of the cold weather exceeded the rate of 90,000,000 gallons per day.

The average amount of the night consumption of water between the hours of 1 and 4, and its extent in comparison with the average consumption for the entire day, is more graphically shown by the accompanying diagram. Notwithstanding the great waste during the past year, indicated by the diagram, there has been a notable decrease from the preceding year in the night rate of consumption, not only during the winter months, but also in the latter part of the year, which seems to show that the increasing use of meters in a few cities and towns and a more careful inspection of leakages are causing a reduction in the quantity of water which is now so wantonly wasted.

The number of new meters which have been set during the past year in the municipalities of the District was 4,257, a number greater than in any previous year, and exceeding by about 1,000 the number of new services which were installed. The greater number of these meters were set in Malden, Somerville and Chelsea, and more especially in Quincy and Swampscott. In two or three of these municipalities the result has seemed to be a decided and gratifying decrease in consumption.

In its report to the Legislature for last year the Board urged the making of consumption an element in the assessment of the city of Boston as well as in the assessments payable by the other cities and towns, believing that the making of consumption an important element in its assessment would also influence the city of Boston, which pays so large a proportion of the total amount, to take measures, by the introduction of meters and more rigorous inspection, for the decrease of waste and leakage.

The Legislature last year passed an act putting the city of Boston on the same basis as to assessments as the other cities and towns in the District. This Act was made to apply to the assessments of Boston during the coming year.

It is not, however, solely in order to reduce current expenditures for the maintenance and operation of works that a decrease in the

unnecessary use and waste of water is demanded; the larger demand comes from the necessity, if such decrease in consumption is not effected, at an earlier period of seeking additional sources of water supply and beginning the construction of large and expensive works. Such additional extensions and constructions, before they are called for by the natural increase of population, will add unnecessarily to the burdens of the municipalities concerned, and will require the taking of properties and privileges from citizens in other parts of the Commonwealth. The Board, as in its last report, "urges upon the various municipalities of the District the adoption of measures, through the introduction of meters, rigorous inspection or otherwise, which shall tend to decrease the unnecessary consumption, and to save unnecessary burdens which fall not only upon the people of the District itself, but, in case of uncalled-for extensions of works, upon residents of other portions of the Commonwealth, whose lands are taken, whose other properties are affected in value, and whose business interests are impaired."

## IX. ELECTROLYSIS.

No great improvement has been found in the electrical conditions. The investigations and experiments which had been in progress relative to the extent of the injury done to the water pipes by the underground electric currents, and which have been made for the purpose of overcoming and reducing the injuries which have resulted, have been continued during the past year. If anything, the districts in which the damages occur seem to be extending. In general, the disintegration had not proceeded so far as to require immediate repairs, but the examinations show that the processes are advancing. The pipe lines crossing Chelsea Creek between Chelsea and East Boston were found to be especially subject to disturbance, and at one point it was found that a hole had been made through the pipe, which had to be repaired. New insulating joints have been inserted at several points in Cambridge, for the purposes of experimentation. The subject is one that requires much investigation, not only in order to discover the amount of damages caused and the responsibility therefor, but also in order to adopt adequate means of protecting the pipes.

## X. BOATING AND FISHING ON LAKE COCHITUATE.

Boating and fishing on Lake Cochituate had so increased in past years, and there had been such an increase in the use of the lands adjoining the shores of the lake for summer cottages and camping purposes, that it was deemed necessary by the Board to make regulations to check this increase, and to protect the lake from the pollution which such increase tended to cause.

Accordingly, it was provided that there should be no boating or fishing upon the northern division of the lake, situated north of the county road known as Lake Avenue, for the reason that from this section the water is delivered directly into the Cochituate Aqueduct, and the danger from the use of water which is polluted, especially by typhoid germs, is very greatly increased where the conditions are such that the water is used in the Metropolitan District within a comparatively short time after pollution.

Boating was allowed upon the remainder of the lake, in boats which had been registered in accordance with regulations made by the Board, by persons to whom licenses were issued for the purpose. The season was limited to the period beginning April 1 and ending September 20, and the number of boats to be registered was restricted to 125. A fee of $1 was required for registration, and the owner of the boat received a plate bearing a number, which it was required should be attached to the boat in such position as always to be kept in sight.

Fishing was permitted during this season in the same portion of the lake in boats which were duly registered and used in accordance with the requirements of the Board.

Permission was also given to fish from the highway during this season, and at other seasons to enter from the highway and fish through the ice in the same portions of the lake where boating was permitted.

It was provided that applications for registration of boats should be made on or before the first day of April. The total number of persons who applied for registration was 163, but less than 125 in number applied before the time thus fixed for the making of applications. Permission was granted for the registration of 125 boats; in 6 cases the applicant was permitted to use an additional boat or tender, but in all these cases he had had in use 2 or more boats the

previous year. Of the 125 boats registered, 108 belonged to owners resident in Natick and Cochituate, the territory immediately surrounding the lake, and 17 of the boats belonged to owners of cottages upon the marginal lands surrounding the shores of the lake. No resident of Natick or Cochituate and no owner of a cottage upon the margin of the lake who applied within the time limited for application was refused registration.

Three actions were brought for violation of the regulations, and in all of them convictions were obtained. Two of the parties paid small fines, and one case, which was brought against the owner of a cottage who made an application for the use of 3 boats long after the time limit for applications had expired and when the full number had been granted, appealed to the higher courts. As this owner persisted in subsequent violations of the regulations, an injunction was applied for to prevent his use of boats, which was granted. An appeal has been taken to the Supreme Court, upon the ground that the Board had no power to make the regulations for the prevention of boating.

Two inspectors were employed during the summer season to enforce the regulations affecting the use of boats, and also to see that all proper sanitary measures should be adopted by the occupants of cottages and by other persons camping near the lake, in order to prevent the pollution of the water.

The regulations adopted and the measures taken have been successful in improving the sanitary conditions in and around the lake. The owners of the registered boats have carefully observed the regulations which have been made, and there has been a decided reduction in the number of persons camping temporarily around the margins of the lake. The sale of lots for cottage or camping purposes has been discouraged, as well as schemes for the use of adjoining lands for picnic purposes.

It has been determined to permit boating during the year 1907 in like manner upon the portions of the lake other than the northern division. In the granting of registration of boats consideration will be given to the question of residence of the applicant, whether in the neighborhood of the lake or otherwise, and of his ownership of a cottage existing prior to March 1, 1906. Applications will be required to be made before the first day of April. A fee of $1 is required for registration, and the owner will, unless he has already

received a plate containing a proper number, receive a plate containing a number, which must be attached to the boat in such position as will be required by the agent of the Board, and must always be kept in sight.

The season for which boating will be permitted will be extended so that, beginning with April 1, it will end on October 15, instead of September 20, as in the preceding year. The owners of cottages situated near the lake will be required, as a condition of retaining their registration, to maintain their premises in sanitary condition satisfactory to the Board.

## XI. LEGISLATIVE ACTS OF THE YEAR 1906.

The legislation of the General Court of the year 1906, authorizing further loans for the Metropolitan Water Works to the extent of $500,000 (chapter 367), authorizing further loans for extensions of the Sewerage Works to the extent of $1,175,000 (chapter 406) and to the extent of $55,000 (chapter 319), relative to annual reports of the Board to the General Court (chapter 235), changing the bases for apportioning the annual assessments for the construction and maintenance of the Metropolitan Water System (chapter 457), and changing the bases for apportioning the annual assessments for the construction and maintenance of the Metropolitan Sewerage Systems (chapter 369), is set forth in other portions of this report.

It was provided by chapter 337 that premiums received from the sale of bonds issued on account of the Metropolitan Water Loan should thereafter be paid into the sinking fund for the extinguishment of the principal indebtedness, instead of being applied to the diminution of the annual assessment as before required; and in like manner, by chapter 338, that premiums received from the sale of scrip, certificates of debt or bonds issued on account of the Metropolitan Sewerage Works should be paid into the sinking fund for the extinguishment of the principal indebtedness, instead of being applied as before in diminution of the assessments for the current year.

By chapter 404 it was provided that all sums of money thereafter received for the admission of a city or town into the Metropolitan Water District should be applied to the payment of the cost of connecting such city or town with the pipes and works of the Metropolitan Water District, and, after such cost was paid, should be paid

into the Metropolitan Water Loan Sinking Fund, the statutes as previously existing having required that sums so received should be deducted from the annual assessments.

By the provisions of chapter 498 the Treasurer of the Commonwealth was required to pay, as a part of the expense of the Metropolitan Water System, the sum of $64,988 to the town of Clinton. This sum was intended to carry into substantial effect an award made by a committee appointed by the Governor in the year 1901 for the payment of $4,000 in each year, in order to indemnify that town for damages caused by the construction of the Metropolitan Water Works. This report of the committee had been made to the General Court of the year 1902, but the award had then failed to receive its confirmation. The Act further provided that all property held by the Board in the town of Clinton, outside of the dam and dike, used in the generation or sale of electricity for power or for manufacturing purposes, should be subject to taxation.

The Treasurer of the Commonwealth was required by the provisions of chapter 533 to pay annually, as a part of the expenses of the Metropolitan Water System, to the town of Holden an amount equal to the average assessment for the three years preceding the purchase of the property by the Commonwealth on all real estate, including water rights and machinery acquired and held by the Commonwealth as a part of the Metropolitan Water System, such payment to be in lieu of taxes or other payments; it being, however, provided that if any buildings standing on land so acquired and held should be removed and remain in the town, the value of such buildings as newly located should be deducted from the valuation for such assessment.

## XII. APPORTIONMENT OF ANNUAL ASSESSMENTS FOR METROPOLITAN SEWERAGE SYSTEMS.

The Board in its last report called the attention of the Legislature to the necessity under the existing laws of providing for a new apportionment of the assessments for the North Metropolitan District, but suggested that, as all the five commissions appointed to make the apportionment on the two Metropolitan systems since the beginning of the works had adopted the same bases of apportionment, there would seem to be good reason for fixing the bases of apportionment by legislation, and so avoid the expenditures which were

attendant upon the appointment of commissions for each succeeding period of five years.

The Legislature in accordance with this suggestion passed an act by which it was provided that the proportions in which each of the cities and towns belonging to the North and South Metropolitan Sewerage districts, respectively, should make payments, in order to meet the interest and sinking fund requirements, based upon the respective taxable valuations of the said cities and towns, and that the proportions in which each of the cities and towns should make payments to meet the cost of maintenance and operation of the respective sewerage systems should be based upon the respective populations of the cities and towns. It was further made the duty of the Board annually upon these bases to determine for each system the proportion in which the cities and towns should make payments into the treasury of the Commonwealth for these purposes, and it was made the duty of the Treasurer of the Commonwealth, in accordance with the proportions so determined, to fix the respective assessments of the cities and towns of the District.

## XIII. RECOMMENDATIONS FOR ADDITIONAL WATER LOANS.

The Board, in its preliminary report to the Legislature of the year 1907, recommended that provision be made for further additions to the Metropolitan Water Loan Fund sufficient to carry on the necessary construction for the coming year and to meet liabilities already accrued. The recommendations made were as follows: —

It appears from the financial statement that on December 1, 1906, the balance remaining on account of the Metropolitan Water Loan Fund, for the construction and acquisition of works, was $377,173.50.

The Wachusett Dam and Reservoir, the last of the greater works whose construction was specifically called for during the first period of ten years by the Metropolitan Water Act of 1895, have been structurally completed. Some additions to the gate-house at the dam, additional grading and preparation of the marginal lands of the reservoir, and work upon the bed of the reservoir, consequent upon the gradual filling with water, must be done during the present year.

The completion and equipment of the new pumping station in Arlington, whose construction was begun during the past year, necessary additions to

the Chestnut Hill pumping stations, and some minor work upon the aqueducts and pipe lines are demanded.

There remains much to be done for the improvement of the watersheds and for preventing the pollution of the sources of water supply, both for the carrying out of the original plans and in order to meet other demands which are constantly made in the interests of more complete sanitation. Not so much progress was made during the past year in the drainage of swamps and in the building of filter-beds and other works upon the watersheds as was contemplated, but the completion of works begun and the carrying out of undertakings demanded call for considerable expenditures during the current year.

The completion of the Dam and Reservoir has left for final settlement some of the most important contracts connected with the operations of the Board; and naturally at this stage of the work there are left many other claims upon which there has been failure to reach a voluntary agreement, and consequently settlement is to be effected by suits in court. These suits, numbering about 100, are in a few cases for property taken, but by far the larger part arise under claims for damages by reason of alleged depreciation in value of property not taken, or injury to estates by the operations of the Board, or for injuries to established business, — indirect damages, in reference to which agreement is especially difficult, and the amounts recoverable in court cannot be accurately estimated in advance.

Prior to the year 1906 loans for the construction and acquisition of works to the amount of $40,000,000 had been authorized, and last year further loans to the extent of $500,000 were authorized.

It is estimated that the requirements above specified may call for the expenditure of $670,600; but, owing to the balance remaining unexpended, additional loans to so great an amount will not be required. It is recommended that the Treasurer be authorized to issue from time to time, as may be required, additional metropolitan water loans for these purposes, to an amount not exceeding $300,000.

Additional pipe lines and further pumping facilities will be required in the near future, and accidents or emergencies in extensive works of water supply may call for expenditures not anticipated; but the Board believes that the construction of other works than those above enumerated may be deferred for the present year.

## XIV. FUTURE WORK.

The Board is charged with the maintenance and operation of all the various works of water supply and for the conveyance and distribution of water to the various municipalities of the Metropolitan Water District, and with the collection and disposal of the sewage

from the various cities and towns constituting the Metropolitan Sewerage District. The sums which it will be necessary for the Board to expend for this work of maintenance and operation for the coming year are estimated to amount to about $650,000.

A portion of the immediate duties before the Board during the coming year, in connection with the Water Works, as has been stated in a previous page, is the settlement of many claims and suits which have arisen especially in connection with the substantial completion of the Wachusett Dam and Reservoir, and of many suits which have been brought for the collection of indirect damages, the limitation of the period in which such suits could be brought having recently expired.

The work of construction contemplated for the coming year does not involve the construction of any large and important works, but rather consists in the finishing up of works already begun, and in the carrying out of many projects which have been made for the improvement of the watersheds and for the prevention of pollution of the sources of water supply.

The Board in its report to the Legislature for the preceding year presented a statement of the works which, as it appeared, might be required sooner or later during a period of the next few years. The estimated cost of these works was a little exceeding $1,800,000. Nearly all of these works were contemplated or formed a part of the scheme presented by the State Board of Health in its report in the year 1895, and in general were works whose construction it was stated would be called for perhaps in the second period of ten years following the year 1895. It is the opinion of the Board that the beginning of the construction of the larger works embraced in the list can be deferred, at least for the present year. The building of some of the main pipe lines cannot, however, be put off for a longer period than one or two years. The construction of others of these works is dependent upon the success of efforts made for checking the waste and unnecessary use of water. The Board, however, in making these estimates included no sums for the acquisition of new sources of water supply, and for machinery which may be needed for the production of power at the Wachusett Dam.

The Legislature of last year authorized the issue of bonds to an amount not exceeding $1,175,000 for the purpose of constructing an extension of the High-level Sewer of the South Metropolitan

System, from the corner of Centre and Perkins streets in Jamaica Plain through West Roxbury, Brookline and as far as Oak Square in Brighton, for which detailed plans had been made. The active work of construction has begun, and will occupy a period of two or more years. The further extension of this sewer through the city of Newton to a point near the Charles River, which is a part of the general plan submitted, will not immediately be called for unless such extension is required for districts not now embraced within the South Metropolitan System.

When the State Board of Health presented its report in the year 1895, recommending the establishment of the Metropolitan Water Works, it accompanied the report with an estimate of the various amounts which would be required to carry out its recommendations. The Legislature of that year, in enacting the Metropolitan Water Act, not only required the Board then instituted to carry out the various recommendations made by the State Board of Health, but it also required the Board to take and pay for the works held by the city of Boston for the purposes of water supply, as well as Spot Pond and the lands under and surrounding the same, owned by the cities of Malden, Medford and Melrose, to construct various minor works, and also to make compensation for various claims for indirect damages, for all of which, calling for additional expenditures, no estimates were made. Subsequent legislatures have also made further requirements calling for large expenditures, but making no further appropriations for meeting them. The State Board of Health estimated the cost of the works called for by its recommendations to be $19,045,800. It further estimated that an aqueduct to Weston would have to be constructed in the latter part of the period embraced within the first ten years, with main distributing pipes extending into the District, at a cost of $4,982,000. It estimated that works which would be called for during the second ten years would require an additional expenditure of $1,300,000.

Not quite all of the works regarded by the State Board of Health as necessary for the first period of ten years have yet been constructed. Some of the works estimated for have been omitted as not being necessary under the matured plans of construction, while, on the other hand, many of the works constructed have been built with greatly increased capacities. Making deductions for the works which have thus been omitted, but making no addition for the works

built with increased capacities, the Board, from careful computations made by its engineers, believes that the cost of the works upon which estimates were originally made by the State Board of Health have not been exceeded in actual construction. While some of the works embraced in the original estimates still remain to be built, it is believed that their construction would not carry the total of the estimates for the works recommended beyond the sums stated by the State Board of Health, were not increased expenditures required on account of the great rise in the cost of labor and materials.

The reports of the Chief Engineer and of the Engineer of the Sudbury and Distribution departments, relating to the Water Works, and the report of the Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE.
HENRY P. WALCOTT.
JAMES A. BAILEY, Jr.

Boston, February 27, 1907.

# REPORT OF THE CHIEF ENGINEER.

*To the Metropolitan Water and Sewerage Board.*

GENTLEMEN: — During the year ending December 31, 1906, I have been engaged, as you know, upon consulting work in various places to such an extent that I have devoted only about one-fifth of my time to the Metropolitan Water Works. As the amount of compensation was proportioned to the time of service, it seemed advisable that I should continue as Chief Engineer until the completion of the larger contracts and the subsequent adjustment of claims in connection with them. During my absence Mr. Dexter Brackett, Engineer of the Sudbury and Distribution departments, has supervised the whole of the work, and even when I have been present he has continued to supervise nearly all of the work. It therefore seems appropriate that the report of the operations of the Engineering Department should be made by him.

Respectfully submitted,

FREDERIC P. STEARNS,
*Chief Engineer.*

BOSTON, January 1, 1907.

*To the Metropolitan Water and Sewerage Board.*

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Water Works for the year ending December 31, 1906.

## ORGANIZATION.

Thomas F. Richardson, Engineer of the Dam and Reservoir Department, was absent by permission, from January 20 to March 9, and on July 20 he resigned to accept the position of Chief Engineer

and Resident Manager of the Federal Construction Company. Mr. Richardson had been connected with the department since its organization, in 1895, and previous to that time was employed upon the preliminary investigations for the Metropolitan Water Supply, which were made under the direction of the State Board of Health. During his term of service he had charge of the surveys for the location of the Wachusett and Weston aqueducts, of the borings and investigations preliminary to the location of the Wachusett Dam and the North Dike, and was in responsible charge of the construction of the Wachusett Aqueduct, the Wachusett Dam and the South Dike. He also had charge of the construction in the Wachusett Reservoir during the year 1905.

Caleb M. Saville, Division Engineer in the Distribution Department, resigned on June 2, in order to accept a position with French & Bryant, Civil Engineers of Brookline, Mass. The work of which he was in charge, consisting of the supervision of the operation of the Venturi meters and of determining the quantity of water used in the different cities and towns of the Metropolitan Water District, has been subdivided between Alfred O. Doane, Division Engineer, and Samuel E. Killam, Office Assistant.

John W. Lynch, Engineer of Pumping Stations, resigned his position on June 20, on account of ill health. Mr. Lynch was in charge of the high-service station at Chestnut Hill for several years prior to 1898, when the station was owned and operated by the city of Boston. From January 1, 1898, when the station passed into the control of the Metropolitan Water Board, until the date of his resignation, he was in charge of the stations at Chestnut Hill, and after December 20, 1900, he also had general charge of the machinery in all of the water works pumping stations.

Arthur E. O'Neil has been in charge of the stations at Chestnut Hill since August 16.

At the close of the year the principal assistants employed under the direction of the Chief Engineer and the Department Engineer were as follows: —

| | |
|---|---|
| Alexander E. Kastl, | . *Division Engineer in Charge of the Dam and Reservoir Department.* |
| William E. Foss, . | . *Division Engineer, Distribution Department.* |
| Alfred O. Doane, . | . *Division Engineer, Distribution Department.* |
| Elliott R. B. Allardice, | . *Division Engineer, Dam and Reservoir Department.* |

| | |
|---|---|
| Benjamin F. Hancox, | . *Assistant in Charge of Drafting Department.* |
| Samuel E. Killam, . | . *Office Assistant.* |
| Charles E. Haberstroh, | . *Assistant Superintendent, Sudbury Department.* |
| George E. Wilde, . | . *Assistant Superintendent, Distribution Department.* |
| Arthur E. O'Neil, . | . *Engineer of Pumping Stations.* |
| William W. Locke, | . *Sanitary Inspector.* |

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 64, and at the end of the year 48.

There has also been a maintenance force, exclusive of the engineers mentioned above, averaging 217, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts, pipe lines and other work.

Special gangs of men have been employed in constructing ditches for the drainage of swamps in Sterling, Holden and Princeton, in cleaning weeds from the bottom of the Wachusett Reservoir, in erecting curbing and fences and building granolithic surface at the Wachusett Dam, in completing the South Dike, in resurfacing roads and building gutters in Clinton and West Boylston, in stripping soil and in forestal work. The force thus employed has averaged 74.

### Arrangement of Report.

The arrangement which has been adopted in the reports of previous years is followed in continuing this report, and the work charged to the construction account is kept separate from that charged to the maintenance account; but, as the work of construction and maintenance is supervised by the same principal engineers, and in very many cases the assistants are engaged upon both classes of work, it is not feasible to make a complete separation.

## CONSTRUCTION.

### Contracts.

A detailed statement of the contracts made and pending during the year is given in Appendix No. 1. The following statement gives a summary of all the contracts charged to construction from the beginning of the work to the end of the year 1906: —

| Portion of Work. | Number of Contracts. | Approximate Amount. |
|---|---|---|
| Wachusett Reservoir, | 38 | $3,055,252 12 |
| Wachusett Dam, | 17 | 1,754,940 68 |
| Relocation Central Massachusetts Railroad, | 6 | 512,527 67 |
| Wachusett Aqueduct and Clinton sewerage, | 19 | 1,516,259 67 |
| Sudbury Reservoir, the portions of contracts not performed at the time they were assumed from the city of Boston, | 11 | 583,220 54 |
| Sudbury Department, reservoir, filter-beds, pipe lines and improvement of Lake Cochituate, Metropolitan Water Works contracts, | 22 | 956,508 17 |
| Weston Aqueduct and Reservoir, | 26 | 2,212,403 31 |
| Distribution Department, including pipes, valves and special castings purchased for other departments, | 163 | 4,565,975 77 |
| Totals, | 302 | $15,157,087 93 |

| | |
|---|---|
| Amount of 4 contracts made in 1906 (approximate), | $43,629 72 |
| Amount of 3 contracts unfinished December 31, 1906 (approximate), | 49,618 00 |
| Value of work done by contract from January 1, 1906, to December 31, 1906, | 46,688 76 |

## DAM AND RESERVOIR DEPARTMENT.

The principal construction work in this department has been in connection with the completion of the Wachusett Dam, the building of filter-beds in Sterling, the construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir in Sterling, Holden and Princeton, and the final clearing of the bottom of the Wachusett Reservoir between elevations 365 and 385.

### Wachusett Dam.

*Contract No. 195, McArthur Brothers Company.*

At the beginning of the year the only work remaining to be done under this contract was the completion of the excavation of about 1,400 cubic yards of earth and 1,900 cubic yards of rock in the waste channel below the dam. This work was in progress at the beginning of the year, and was completed on February 27. The following table gives the total amount of work done to the end of the contract, based on the final estimate: —

| | |
|---|---|
| Earth excavation (cubic yards), | 274,087 |
| Rock excavation (cubic yards), | 102,640 |
| Rubble stone masonry (cubic yards), | 251,920 |
| Ashlar masonry (cubic yards), | 9,037 |
| Dimension stone masonry (cubic yards), | 2,742 |
| Brick masonry (cubic yards), | 1,065 |
| Concrete masonry (cubic yards), | 9,675 |
| Slope paving (cubic yards), | 1,899 |
| Iron and other metal work (tons), | 894 |
| Roadways and paths (square yards), | 9,193 |
| Vitrified pipe for drains (linear feet), | 3,016 |

The following quantities of masonry, used in constructing the roadway arch bridge over the waste channel, are not included in the above table: —

| | |
|---|---|
| Concrete masonry (cubic yards), | 322 |
| Ashlar masonry (cubic yards), | 83 |
| Dimension stone masonry (cubic yards), | 87 |

*Additional Work.*

The construction of the granolithic surface on the top of the dam, including the abutment and bastion, and the granolithic walk from the abutment to Boylston Street, was begun on June 1 and completed on July 10. The granolithic surface has an average thickness of 5½ inches. On the abutment and bastion it is divided into blocks about 11 feet square, and each block is reinforced longitudinally and transversely with ¼-inch corrugated steel bars spaced 18 inches apart. Between the terminal structures it is divided into blocks by joints across the dam spaced 9 feet 9 inches apart, placed opposite the brass posts of the fence on top of the dam. Each block is reinforced across the dam with ¼-inch corrugated steel bars spaced 18 inches apart, and also with electrically welded fabric made of No. 10 wire with a 10-inch by 12-inch mesh. Over the upper gate-chamber the granolithic surface is further reinforced with ½-inch corrugated steel bars spaced 4 feet 5 inches apart. Before placing the granolithic surface the top of the dam was coated with powdered mica, for the purpose of preventing adhesion between the masonry of the dam and the granolithic surface, thus allowing them to contract and expand independently of each other. The joints between the blocks are about half an inch wide, extend the full depth of the granolithic surface, and were filled with asphaltum.

The granolithic walk from the bastion to Boylston Street is 10 feet wide and 8 inches thick, and divided into blocks 10 feet square. The blocks are reinforced with the electrically welded fabric.

The work was done under the supervision of the Simpson Brothers Corporation of Boston, which furnished the skilled labor; the ordinary labor and materials being furnished by the Board. The total area laid was 23,610 square feet.

A brass fence has been erected on each side of the top of the dam between the terminal structures, the work being done by the day-labor force in March and April. The design of the fence was described in the annual report for the year 1905.

Steel gates have been erected at the southeasterly end of the dam, where it joins the abutment, and a steel fence has been erected around the platform at the bastion.

A steel fence 460 feet long, supported on granite curbing and with granite posts at the gateways and corners, has been erected at the Boylston Street entrance to the dam. It has three gates, one opposite the end of the granolithic walk leading to the dam, the others at either end, opposite the gravel paths leading to the abutment. A gravel walk with granite edgestones has been built along the street, also gravel paths from the ends of the fence to the abutment.

The work of erecting the steel gates and fences and building the gravel walk and paths was done by the day-labor force. The steel gates and fencing were furnished by Henry Parsons & Son of Marlborough, Mass., and the granite posts, curbing and edge stones by F. A. McCauliff of Fitchburg, Mass.

An iron pipe rail fence 235 feet long has been erected on top of the retaining wall, extending along the easterly side of the waste channel from the bastion to the Central Massachusetts Railroad bridge.

Early in the year a permanent connection was made between the 48-inch equalizer pipe in well No. 4 of the lower gate-chamber and the 24-inch pipe line supplying water to the Lancaster Mills. For this purpose 269 feet of 12-inch cast-iron pipe were laid, controlled by a 12-inch valve, including a 12-inch Venturi meter for use in measuring the quantity of water delivered to the mills.

A 10-inch Venturi meter and a 10-inch valve and valve chamber have been set in connection with the 10-inch pipe line from the

lower gate-chamber to the fountain in the inner pool, for the purpose of regulating and measuring the water supplied to the fountain.

The road on the westerly hillside, extending from the grounds below the dam to the bastion, has been improved by the building of 975 feet of paved gutter and seven 8-inch vitrified pipe culverts with drainage inlets in the gutter. The road has also been resurfaced with screened gravel.

The joints in the cobble-stone paved gutter at the foot of the down-stream side of the dam have been pointed with cement mortar, in order to prevent the growth of weeds and the washing out of the stones.

A large pile of loam, which had been stored near the bastion at the northwesterly end of the dam, has been used in grading the hillside; and all the newly finished grounds in the vicinity of the dam which had been covered with soil, but not seeded, have been graded and seeded. There have been planted in beds in the vicinity of the walks and roadways 2,230 shrubs, comprising 31 varieties.

Machinery for a lighting and pumping plant for use at the dam, to be installed in the lower gate-chamber and operated by water power, has been delivered, but is not yet in position. It consists of a 9-inch turbine, furnished by the Holyoke Machine Company, which is to be directly connected to a 22½ kilowatt generator. The generator will furnish current for lighting the building, for operating a 10 horse-power motor connected with a 6-inch submerged pump to be used for pumping water from the wells in the lower gate-chamber, and will also furnish current for operating the electric motor on the crane used for handling stop-planks and screens in the upper gate-chamber. The generator and motor were built by the Stanley Electric Company, and are being furnished and installed by the Frank Ridlon Company.

## South Dike.

At the end of 1905 about 1,000 cubic yards of material still remained to be placed for the filling of the gap in the South Dike, through which had passed the quarry railroad used in the construction of the Wachusett Dam. This filling was completed by a day-labor force working at various times between April 7 and September 3. The surface was finished with soil to a depth of 18 inches, and seeded.

WACHUSETT DAM WITH ENTRANCE FROM BOYLSTON STREET AND ABUTMENT AT THE SOUTHEASTERLY END.

RELOCATION AND CONSTRUCTION OF ROADS.

All the contract work on the last of the new highways required on account of the construction of the Wachusett Reservoir was completed in November, 1905; but some work of a minor character, not included in the contracts, remained to be done this year, such as paving gutters subject to erosion, improving the drainage, building additional guard rail fences and repairing the surfacing where it had settled or had been damaged by heavy teaming during the construction of other work on the reservoir.

In West Boylston the following work has been done: On the highway crossing the Stillwater River arch the northerly gutter was paved with cobble-stones from North Main Street, in Oakdale, to the entrance to the grounds of the Worcester County Truant School, a distance of about 2,200 feet, and the gravel walk next to the gutter surfaced from the Worcester, Nashua & Portland Railroad to the Stillwater arch, a distance of about 700 feet. On the new location of Worcester Street, south of Prospect Street, the westerly gutter was paved with cobble-stones for a distance of about 500 feet. Newton Street was surfaced with gravel for a distance of about 2,200 feet southerly of the Quinepoxet River arches, and Crescent Street for a distance of about 2,600 feet northerly of Prospect Street. A 12-inch iron pipe culvert was built on Crescent Street, near the junction of the new and old locations of the street. Much other miscellaneous work was done, such as building and painting additional highway railings, placing sand on those parts of the broken-stone highways which had begun to disintegrate, grading gutters, and grading and surfacing gravel sidewalks.

During the construction of the dam, Boylston Street, in the town of Clinton, from the Clinton-Boylston town line to the dam, had been badly worn by heavy teaming; therefore it was decided to resurface this part of the street with broken-stone screenings. The work was commenced on July 21 and completed on August 20. The steam road roller and the watering cart used on the work were hired from the town of Clinton. At the request of the chairman of the road commissioners, an additional length of street was surfaced in order to reimburse the town for the use of the road roller and watering cart. The length of street surfaced is 5,697 feet, of which 4,419 feet is the length from the town line to the dam, and 1,278

feet the additional length surfaced below the dam to reimburse the town for the use of the road roller and watering cart. In this work 454½ tons of broken-stone screenings were used. Wooden rail fences, aggregating 655 feet in length, were built at several points along the westerly line of Boylston Street, between the Wachusett Dam and the Boylston town line.

## Removal of Soil.

### *Additional Soil Stripping.*

On both shores of the Wachusett Reservoir near Sawyer's Mills, and on the southerly shore near Boylston Centre and Pine Hill, additional clearing, grubbing and removing of soil have been done back of where the steep banks, acted upon by waves, frost and rain, have caved away and retreated nearly to the limit of the original soil stripping or of the additional soil stripping done last year. The soil has been stripped along an aggregate length of about 5,000 feet of shore line for a width of from 10 to 20 feet, the aggregate area being 1.40 acres.

### *Cleaning of the Reservoir Bottom.*

The final cleaning of the reservoir bottom was done between elevations 363 and 385, from August 25 to December 8, and consisted in removing and disposing of the weeds, grass and bushes which had grown up since the original stripping of the soil or since the last cleaning. Over the greater part of the area the ground was harrowed with spring-tooth harrows, and the weeds, grass and bushes, together with the roots, were afterwards raked and burned. Over the remaining area, where the harrows could not be used on account of the ground being rocky, steep or wet, the weeds, grass and bushes were mowed close to the ground, and afterwards raked and burned. There was cleaned a total of 1,205 acres of ground, at a cost of $9,585, or an average cost of $7.95 per acre. This cost per acre is much larger than for the cleaning done during the previous year, for several reasons. During the past year a larger proportion of the area was cleaned by harrowing and raking, — a more expensive method than by mowing and raking, but giving better results; also, for the reason that more than half the area cleaned had not been touched since the original stripping was done several years ago, and the growth was consequently heavy. The rate of wages paid was also higher than in previous years.

### *Shore Protection.*

From a point about 500 feet south of the Wachusett Dam, the easterly shore of the reservoir, in the vicinity of the flow line, has been covered with cobble-stones to a depth of about 9 inches, for a distance of 1,250 feet and a width of 20 feet, in order to protect it from wave action. On the northwesterly shore of the reservoir, just above the northwesterly end of the waste weir of the dam, the slope of the ground in the vicinity of the flow line was steeper than the natural slope of the material, and in order to protect this stretch of shore from being undermined by wave action, it has been covered with gravel for a distance of 165 feet.

## Relocation of Railroads.

The principal part of the contract work upon the relocation of railroads was completed in 1903. As noted in previous reports, the only part not completed was on what is known as Section 2 of the relocation of the Central Massachusetts Railroad, Contract No. 195A (245), McArthur Brothers Company, near the westerly end of the Wachusett Dam, where it was necessary to build a temporary location for the Central Massachusetts Railroad, in order not to interfere with the use of the traveling cableways used in connection with the construction of the dam. Last year this gap in the permanent line was finished and put in operation, and the removal of the embankment of the temporary line was then begun and was nearly completed at the beginning of 1906. The work was completed on January 11.

The following table gives the total amount of work done to the end of the contract, based on the final estimate: —

| | |
|---|---|
| Earth excavation (cubic yards), | 43,012 |
| Rock excavation (cubic yards), | 56,033 |
| Tunnel excavation (cubic yards), | 18,967 |
| Rubble stone masonry (cubic yards), | 987 |
| Concrete masonry not in tunnel (cubic yards), | 2,443 |
| Concrete masonry in tunnel (cubic yards), | 2,208 |
| Dimension stone masonry (cubic yards), | 833 |
| Face stone masonry for railroad arch bridge (cubic yards), | 340 |
| Dry paving (cubic yards), | 158 |

The only day-labor work in connection with the relocation of railroads has been the sowing of grass seed on the slopes of the

railroad embankments between the end of the viaduct and the railroad arch bridge over the waste channel, and the gathering up and disposing of some old material from the old location of the Central Massachusetts Railroad.

## Improvement of Wachusett Watershed.

### *Drainage of Swamps.*

The construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir, which was suspended on July 7, 1900, was resumed during the year, and has been in progress in three swamps, one in the town of Sterling just south of Sterling Centre, and two in the towns of Holden and Princeton above the junction of Trout and Governor brooks.

The methods of carrying on the work have been substantially the same as described in the annual report of January 1, 1899. In all cases where ditches have been built permission has been obtained from the owners of the land for their construction and maintenance, without payment to the owners.

The ditches constructed have, with few exceptions, a board bottom 1 foot wide, with 4-inch by 4-inch triangular wooden strips rabbeted at the square corner to the edges of the board. The board bottom is nailed to 2-inch by 4-inch wooden cross-pieces, 2 feet long, spaced about 3 feet apart and laid across the bottom of the excavation. The triangular strips make wooden sides to the ditch 3 inches high, and serve as a footing for the stone paving on the slopes of the ditch. As the bottom of the excavation for the ditches is generally in water and the material very soft, it is necessary to use some form of board bottom in order to preserve the grade of the ditch and afford a support for the slope paving, and the form of bottom used facilitates the cleaning of the ditches. Where the ditches have steep grades and the ground is more firm, the bottom is also paved with stone; and where the ground is stony, no paving is used.

The swamp south of Sterling Centre has an area of 26 acres, and the watershed tributary to its outlet has an area of 225 acres. The village of Sterling Centre is at the northerly end of this watershed, and a brook rising in the village flows into the swamp. The drainage of the swamp has been accomplished by means of two ditches, having an aggregate length of 6,173 feet, one on either side of the

DITCH FOR SWAMP DRAINAGE ON WACHUSETT WATERSHED IN HOLDEN.

swamp. The depth of the ditches is generally 2½ to 3 feet, and the slope paving is carried to a height of 1 foot above the board bottom. The work was done by a day-labor force, between June 11 and August 20.

The maximum force employed was 39 men and 2 horses, during the week ending July 21, and the average force was 24 men and 2 horses.

The amount of work done was as follows: 6,173 linear feet of ditches, with board bottom and stone paving on the sides; 11 farm crossings, and 1 culvert repaired under the New York, New Haven & Hartford Railroad where one of the ditches crosses it.

The two swamps above the junction of Trout and Governor brooks in which work has been done are partly in the town of Holden and partly in the town of Princeton north of the village of Quinepoxet.

The swamp on Trout Brook has an area of 72 acres, and the area of the watershed above its outlet is about 750 acres. The system of drainage consists of two marginal ditches in the upper half of the swamp where it is wide, uniting into one ditch in the lower half of the swamp where it is narrow. Below the swamp the brook was improved by clearing out the brush and removing obstructions in its channel for a distance of 600 feet in order to increase its carrying capacity. Several minor brooks tributary to the ditches were also improved from their junction with the ditches to the edge of the swamp. The depth of the ditches is generally 1½ to 2 feet, and the slope paving is carried to a height of 8 to 12 inches above the bottom. The work, which was done by a day-labor force, was commenced on June 25 and completed on September 18.

The maximum force employed was 28 men and 3 horses, during the week ending July 28, and the average force was 25 men and 2 horses.

The amount of work done was as follows: —

| | |
|---|---|
| Ditches with board bottom and stone paving on the sides (linear feet), | 7,088 |
| Ditches with stone paving on bottom and sides (linear feet), | 207 |
| Ditches without board bottom or stone paving (linear feet), | 1,635 |
| Total length of ditches (linear feet), | 8,930 |
| Brooks improved (linear feet), | 916 |
| Farm crossings, | 7 |
| Watering places, | 4 |

The swamp on Governor Brook has an area of 216 acres, and the area of the watershed above its outlet is about 1,625 acres. The drainage of this swamp will require the construction of 28,400 linear feet of ditches. Work was commenced on this swamp on September 19, and was suspended on December 1, on account of cold weather and snow. The depth of the ditches thus far constructed is generally 1½ to 3 feet, and the slope paving is carried to a height of 1 to 2 feet above the bottom. In connection with this work a 2-foot by 2-foot concrete culvert was built across the Quinepoxet-East Princeton highway, where one of the ditches crosses the highway at the Holden-Princeton town line. The old culvert at this place was not properly located, and was of insufficient capacity. A highway watering place was also built to replace the one at the old culvert. The work has been done by a day-labor force.

The maximum force employed was 27 men and 2 horses, during most of the month of October, and the average force was 24 men and 2 horses.

The amount of work done was as follows: —

| | |
|---|---|
| Ditches with board bottom and stone paving on the sides (linear feet), | 4,095 |
| Ditches with stone paving on bottom and sides (linear feet), | 112 |
| Ditches without board bottom or paving (linear feet), | 390 |
| Total length of ditches (linear feet), | 4,597 |
| Brook improved (linear feet), | 120 |
| Farm crossings, | 5 |
| Watering places, | 3 |
| 2-foot by 2-foot concrete highway culvert, | 1 |

The total length of ditches constructed during the year was 19,700 feet, equal to 3.73 miles, at a cost, exclusive of engineering, of $9,886, or $0.502 per linear foot. This cost is somewhat higher than that of previous years, due to the higher rate of wages paid, the higher cost of materials, and to being obliged to begin with foremen and laborers who were not familiar with the work. The cost of the work includes the cost of building the culvert, farm crossings and watering places.

On all the swamp drainage work done during the year, the maximum force was 63 men and 2 horses, during the week ending July 21, and the average force was 32 men and 3 horses.

Since November 23, 1899, when the drainage of swamps in the Wachusett watershed was commenced, there have been constructed 34,748 linear feet of ditches, equal to 6.58 miles.

*Sterling Filter-beds.*

Plans and specifications for the construction of four filter-beds, to be used for filtering the water of a small brook which has its head waters in the village of Sterling Centre, were completed in July, and a contract for the construction of the beds was made with A. McKenzie & Co. on September 1. The beds are located alongside the brook, about one mile below the village of Sterling, and just below a swamp on which 8,000,000 gallons of water can be temporarily stored whenever the flow of the brook exceeds the filtering capacity of the beds.

The watershed tributary to the brook above the filter-beds is 225 acres. By means of a small concrete dam across the brook the water will be diverted to the filter-beds through a paved channel 382 feet long. There are four beds, each having an area of about half an acre, arranged in two pairs adjacent to each other. The beds are partly in excavation and partly in fill.

The material encountered on the site of the beds, aside from the surface soil, has been gravel with pockets of sand. The soil and other material unsuitable for filtration purposes have been excavated from the site of the beds and used in building the embankments surrounding the beds. The gravel and sand from the parts of the beds in excavation have been used in building the parts of the beds in fill, all stones more than 4 inches in diameter having been removed and used in embankments, paving and elsewhere. The parts of the beds in excavation have been excavated 8 inches deeper than the finished surface, and refilled with screened or selected gravel and sand free from clay and stones more than 1 inch in diameter, and the same kind of material has been used for the upper foot of the parts of the beds in fill.

The surface of the beds in the northerly or upper pair is 7 feet higher than that in the southerly or lower pair. Embankments have been built around and between the beds to such an extent as to have the surface of the upper beds 8 feet below the top of their embankments, and the surface of the lower beds 6 feet below the top of the lower embankments.

From the diverting dam across the brook channel a paved ditch 382 feet long runs to the middle of the northerly or upper boundary of the beds. From the end of the ditch an 18-inch vitrified pipe drain runs between the two upper beds to a concrete manhole opposite their centres. From this manhole a 15-inch vitrified pipe drain runs to a concrete manhole between and opposite the centres of the two lower beds. From the latter manhole a 12-inch vitrified pipe drain runs to the lower boundary of the beds, where it discharges into a paved ditch which joins the brook below the beds. Twelve-inch vitrified pipe drains, one to each bed, running from the sides of the manholes next to the beds, will conduct the water to the beds. Each manhole is provided with a system of shear gates and overflow weirs, arranged in such a manner that water can be turned on to any one bed or any combination of them; and at the same time, if too much water should come, or a bed should become clogged, the water cannot rise higher than within a safe distance of the top of the embankments, as it will flow over the weirs into the other beds, or, if all the beds are full, over the last weir into the 12-inch vitrified pipe drain at the lower end of the beds, which is intended for a safety drain.

As the embankment next to the brook encroached upon it in several places, it was necessary to relocate the brook, and a new channel has been excavated for it along the foot of the embankment. This new channel is paved, and receives the effluent from the underdrains of the filter-beds. Each pair of beds has three lines of underdrains laid at right angles to the new brook channel, those in the two beds farthest from the brook being 6 inches and those in the two beds next to the brook being 8 inches in diameter. For 212 feet above and 60 feet below the diverting dam the brook channel was very narrow, and ran close to the embankment of the New York, New Haven & Hartford Railroad. This part of the brook channel has been relocated farther away from the railroad embankment, and the old brook channel has been filled. The relocated channel is paved from its upper end to 15 feet below the dam. At its upper end it connects with the system of ditches draining the swamp through which the brook formerly ran.

The diverting dam has an opening 4 feet wide, closed with stop-planks. In case it is desired to divert the water from the filter-beds, on account of unusual floods or for any other cause, the

stop-planks can be removed and the water turned into the brook channel below the dam. The diverting dam is so designed that water can be allowed to run over its crest, which is 25 feet in length.

Alongside of the Worcester Consolidated Street Railway track, and adjacent to the high part of the beds, about 350 feet of 12-inch vitrified pipe underdrain will be laid, for the purpose of taking care of any water which may filter into the railway cut.

The following table gives the quantities of work done to the end of the year, and the estimated quantities required to complete the work: —

| | To December 31, 1906. | Estimated Quantities required to complete Work. |
|---|---|---|
| Earth excavation (cubic yards), | 25,270 | 2,900 |
| Concrete masonry (cubic yards), | 41 | 16 |
| Dry rubble stone masonry and paving (cubic yards), | 166 | 60 |
| 18-inch vitrified pipe (linear feet), | 132 | 7 |
| 15-inch vitrified pipe (linear feet), | 269 | 0 |
| 12-inch vitrified pipe (linear feet), | 145 | 375 |
| 8-inch vitrified pipe (linear feet), | 856 | 0 |
| 6-inch vitrified pipe (linear feet), | 880 | 38 |

The maximum force employed by the contractor was 79 men and 14 horses, during the week ending October 6, and the average force was 62 men and 12 horses.

### *Sewage Disposal.*

For the purpose of preventing objectionable drainage from entering the brooks draining into the Wachusett Reservoir, 28 cesspools, 7 cemented vaults and one gravel filter-bed have been constructed, to take care of barn, sink and privy drainage in the towns of Boylston, West Boylston and Holden.

For the purpose of diverting the surface water from the barnyard of the Jennie L. Goodnow farm in West Boylston, a culvert crossing Fairbank Street, opposite the barn, has been closed, and a new stone culvert built across the street at a point about 200 feet north of the old culvert. An open ditch 400 feet long has been excavated and paved for about 150 feet of its length.

*Improvement of River Channels.*

At Warfield's Mill, on the Quinepoxet River above Oakdale, the head of the canal leading from the mill-pond has been filled with earth for a length of about 20 feet, so as to permanently prevent any water from entering the canal.

At the Canada Mills, in Holden, the masonry of the dam for about one-third of its length has been removed sufficiently low to drain the mill-pond, and the head of the canal has been permanently closed by gravel filling.

## Real Estate, Care and Disposal.

During the year about 32 acres of land about the margins of the reservoir, in the towns of Clinton, Boylston and West Boylston, have been graded and seeded. This land required considerable grading, on account of the holes remaining after the removal of 26 houses and 11 barns.

## Forestry.

The work of cutting out fruit, mature and undesirable trees, preparatory to planting, has been done over about 25 acres.

The fire guard, 40 feet wide, along the margins of the land purchased by the Board, has been extended through timber land for about 2¾ miles in West Boylston and Oakdale. An area of 112 acres was planted between April 16 and 28, and an area of 50 acres between October 20 and November 9, with two and three year old seedlings from the Flagg nursery. Of the above, about 60 acres were in heavy grass land, where three-year-old white and Scotch pine, Norway, white and Douglas spruce, European larch and American tamarac seedlings have been planted in rows 6 feet apart each way. The remaining 102 acres were pasture and sprout land, which have been planted with two and three year old white and Scotch pines, and Norway and white spruces, 6 feet or 10 feet apart each way, with chestnuts planted between for fillers, where a suitable filler did not exist. In doing this work the following seedlings from the Flagg nursery have been used: 97,800 white pines, 5,800 Scotch pines, 31,640 white spruces, 7,250 Norway spruces, 22,845 Douglas spruces, 4,100 American tamaracs, 840 European larches, 300 locusts and 17,500 chestnuts. The cost of taking trees from

the nursery and setting them in the ground has averaged $4.54 per 1,000 trees, or $5.07 per acre.

The following table gives information regarding land belonging to the Board above the flow-line of the reservoir (outlying land and land along the Quinepoxet River above the road which formerly crossed the river to the Harris Mills are not included in this table): —

| | Acres. |
|---|---|
| Area of land which was forested when acquired, | 1,463 |
| Area which has been planted with trees, | 1,099 |
| Area to be planted with trees, | 321 |
| Area open and which will probably not be planted, | 300 |
| Area of marginal strip along shores of reservoir, | 197 |
| Total area belonging to Board, | 3,380 |

Two and three year old white pine seedlings and three-year-old arbor vitæ seedlings have been planted along 4 miles of the reservoir margin, and where trees planted in previous years have died, they have been replaced for about ¼ of a mile.

The total length of the flow-line of the reservoir, including 1.28 miles around Cemetery Island, is 39.94 miles. Arbor vitæ and white pine seedlings have been planted in the marginal strip along 29 miles, and arbor vitæ alone on about 2 miles more of the flow-line, where the margin is only 30 feet wide, making a total marginal strip planted of about 31 miles of flow-line. Along the dikes, highways and railroads, for a distance of 5.7 miles, trees will not be planted. There remain about 1.5 miles along the Stillwater River to be planted with trees.

The necessary care has been given to the Flagg and Lamson nurseries during the year. There were transplanted from the nursery beds to the transplant rows at the Flagg nursery 123,980 white pines, 175 hemlocks and 3,870 white spruces. Besides the above stock, this nursery contains, in original seed beds, 283,400 white pines and 101,500 arbor vitæ; also, in transplant beds, 37,500 arbor vitæ.

At the Lamson nursery there are 20,500 sugar maples, 4,010 white oaks, 3,900 walnuts, 14,860 locusts, 2,400 ashes and 1,030 Norway spruces, all of which were transplanted from seed beds to transplant beds in the spring.

The trees cut out were largely apple, chestnut, pine, oak and

hemlock. The logs obtained were for the most part cut into lumber, telephone poles, railroad ties, saw-logs and cord-wood, the principal quantities being as follows: —

| | |
|---|---|
| 20,000 | feet B. M. apple-wood lumber. |
| 6,000 | feet B. M. 2-inch white pine plank. |
| 10,000 | survey stakes. |
| 350 | fence pickets. |
| 168 | railroad ties. |
| 45 | telephone poles. |
| 300 | cords fire wood. |
| 55 | cords saw-logs. |

The apple-wood lumber, railroad ties, saw-logs and most of the cord-wood have been sold. The other material has been used or reserved for use on the work, or remains to be sold.

All the above-mentioned work has been done by day labor, except the manufacture of the lumber, which was done at the saw-mill of Lowe & Flagg in West Boylston.

The maximum day-labor force employed was 41 men and 5 horses, during the week ending April 28.

## Engineering.

In addition to the engineering work necessarily connected with the preparation of the final estimates of contract work finished during the latter part of 1905 and the beginning of 1906, and that connected with the supervision of the contract and day-labor work in progress, the engineering force of the Dam and Reservoir Department has done much other engineering work, principally as follows: —

Plans, specifications and estimates have been prepared for the construction of the Sterling filter-beds. Surveys, calculations and plans have been made for a number of takings of lands which had been acquired by deed. The plans of the Wachusett Dam have been for the most part corrected so as to represent the work as actually constructed, for the purpose of making record drawings of the dam. Much work has been done in revising land plans. Progress has been made on the survey of the marginal line of the watershed, about 34½ miles having been surveyed during the year; about 5 miles remain to be surveyed. The entering on the final record sheets of the elevations of the bottom of the reservoir, taken after

the removal of the soil, has been completed. Contour lines have been drawn on these record sheets, covering an area of about 380 acres, making a total of 3,800 acres covered by final record sheets on which the contour lines have been drawn. Considerable progress has been made in calculating the capacity of the reservoir between elevations 370 and 395, and at the end of the year the results were being tabulated.

## SUDBURY AND DISTRIBUTION DEPARTMENTS.

The principal work charged to construction in these departments has been in connection with the new pumping plant for the northern extra high-service district in Arlington and Lexington, and in making changes at the Chestnut Hill low-service pumping station, for the purpose of adapting one of the engines for pumping to the high-service reservoir.

### Arlington Pumping Station.

A contract for the construction of a brick building, 90 feet long by 46 feet wide, with trimmings of Longmeadow brownstone, together with a concrete coal pocket 33 feet by 27 feet and a brick chimney 70 feet high, was made with C. A. Dodge & Co. on August 23. The contractor began work on the excavation for the building on August 27, and at the close of the year the value of the work done was about half the contract price. The brick walls of the building were completed to the tops of the windows, the chimney was finished, and the concrete foundation for the new engine practically completed.

The Allis-Chalmers Company, which has a contract for furnishing the engine, has done but little actual construction, as it has been evident that the building would not be ready to receive the engine before May 1, 1907. The detailed plans have, however, all been made and approved, and the contractor now promises to hasten the construction work.

### Chestnut Hill Pumping Station.

New suction and discharge piping and valves have been installed in the low-service pumping station in connection with engine No. 7, and the pump chambers of that engine have been strengthened for the purpose of adapting the engine for use in pumping to the high-service reservoir.

## OFFICE FORCE.

During the year the drafting force has made plans for gates and fences at the Wachusett Dam; detailed drawings of the floor of the exciter room, and the arrangement of electrical and pumping plant at the lower gate-chamber at the Wachusett Dam; construction drawings and specifications for a new 64-inch horizontal tubular boiler and setting for the Chestnut Hill high-service pumping station; and drawings and specifications for two 54-inch horizontal tubular boilers for the Arlington pumping station. Several designs were made for a new pumping station building to be built in Arlington, and working drawings of the accepted design, together with specifications for doing the work have been prepared. Plans have been made for the reconstruction of the attendant's house at the Ashland Reservoir; record drawings of the Weston Aqueduct have been completed; and some work has been done on record drawings of the Wachusett Reservoir and Aqueduct and Spot Pond. The whole number of drawings completed during the year was 120. The force employed in the drafting department numbered 5 throughout the year.

The office force, averaging 6 during the year, has performed work of a varied character, a large proportion of which has been connected with the maintenance of the works. This force has supervised the making of plans for land takings on the Wachusett watershed; has made computations in connection with the daily measurement of water used in the several cities and towns supplied from the Metropolitan Works; also the computations for determining the amount of the Metropolitan water assessment to be paid by the several municipalities; and has attended to the procuring of supplies and the making of blue prints and photographs.

## MAINTENANCE.

### Rainfall and Yield.

The total rainfall for the year on the Sudbury watershed has been 44.48 inches, or 1.56 inches below the average for 32 years. On the Wachusett watershed the total rainfall has been 49.08 inches, which is but little below the average for the 10 years during which records have been kept. On both the Sudbury and Wachusett watersheds the yield, although larger than during the year 1905,

has been considerably below the average, as a result of the small rainfall during the months when the greatest percentage is collectible in the reservoirs.

Statistics relating to rainfall and yield of watersheds may be found in Appendix No. 3, tables Nos. 1 to 11.

### Storage Reservoirs.

The quantity of water stored in all of the storage reservoirs on January 1, 1906, was 28,971,900,000 gallons. During the month of January there was an increase of a little less than 2,000,000,000 gallons in the quantity stored, but nearly half of this amount was lost during the first twenty days of the month of February. During the latter part of February and during the months of March and April there was a gain in storage of 13,500,000,000 gallons. During May the gain was small until near the end of the month, when a rainfall of about 4 inches caused a gain of over 3,000,000,000 gallons in storage in three days. The maximum for the year was reached on July 6, when the quantity stored in all the reservoirs was 49,805,200,000 gallons. During July, August, September and October there was an almost continual loss of storage. During November there was practically no loss, followed by a small loss during December; and at the end of the year the quantity stored was 44,153,200,000 gallons.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

*Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.*

| Date. | In Wachusett Reservoir (Gallons). | In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons). | In All Other Storage Reservoirs (Gallons). | Total (Gallons). |
|---|---|---|---|---|
| **1906.** | | | | |
| January 1, | 17,115,300,000 | 6,831,300,000 | 5,025,300,000 | 28,971,900,000 |
| February 1, | 18,159,900,000 | 6,848,600,000 | 5,755,400,000 | 30,763,900,000 |
| March 1, | 18,689,100,000 | 7,000,100,000 | 6,260,500,000 | 31,949,700,000 |
| April 1, | 24,018,300,000 | 6,904,000,000 | 6,606,100,000 | 37,528,400,000 |
| May 1, | 28,981,800,000 | 7,621,900,000 | 6,881,400,000 | 43,485,100,000 |
| June 1, | 32,305,400,000 | 8,031,000,000 | 7,170,500,000 | 47,506,900,000 |
| July 1, | 33,984,900,000 | 7,994,300,000 | 7,191,600,000 | 49,170,800,000 |
| August 1, | 34,062,800,000 | 7,960,600,000 | 6,983,900,000 | 49,007,300,000 |
| September 1, | 33,442,500,000 | 7,865,200,000 | 6,437,200,000 | 47,744,900,000 |
| October 1, | 31,694,700,000 | 7,921,600,000 | 5,793,900,000 | 45,410,200,000 |
| November 1, | 31,149,200,000 | 7,890,300,000 | 5,225,300,000 | 44,264,800,000 |
| December 1, | 31,132,700,000 | 7,762,600,000 | 5,380,900,000 | 44,276,200,000 |
| **1907.** | | | | |
| January 1, | 31,752,900,000 | 6,748,900,000 | 5,651,400,000 | 44,153,200,000 |

*Wachusett Reservoir.* — At the beginning of the year the water in this reservoir was at elevation 344.06, and the reservoir contained 17,115,300,000 gallons of water, or slightly more than one-fourth its full capacity. The yield of the watershed, although greater than in 1905, was still below the average. The highest elevation reached during the year was 367.75, on July 10, when the reservoir contained 34,462,500,000 gallons. Water was drawn for the supply of the Metropolitan District as follows: from January 7 to March 4; March 19 to May 28; June 7 to June 17; June 19 to August 16; August 18 to August 29; September 4 to December 16; and December 26 to December 31. At the end of the year the water stood at elevation 364.57, and the reservoir contained 31,752,900,000 gallons, — a net gain in storage for the year of 14,637,600,000 gallons, which is an increase of 1,931,900,000 gallons over the net gain during the previous year. The only water discharged from the reservoir into the river below the dam was that required for the use of the Lancaster Mills, and to keep the surface of the Lancaster Mills pond up to the crest of its dam. The average quantity as measured at the gaging station below the Lancaster Mills was 3,761,000 gallons per day.

The 50-foot marginal strip along the full reservoir flow-line has been kept mowed, and miscellaneous rubbish has been collected from time to time along the shore line of the reservoir and burned.

A large hole was made in the bed of the Quinepoxet River, just below the highway bridge in Oakdale, during the spring freshets. This has been filled with large stones gathered from the reservoir bottom in the vicinity.

The grass on the north and south dikes has been sold at auction for $1,046.50.

At the Wachusett Dam the maintenance work, consisting of the operation of the valves controlling the flow of water, the cleaning of screens, taking care of the gate-chambers and of the grounds above and below the dam, has been done by 3 gate-keepers, assisted by from 2 to 5 laborers whenever necessary. On Sundays and holidays during the summer season the presence of a large number of visitors on the dam and grounds has made it necessary to keep several of our men, who have been qualified as special police, on duty to preserve order and protect the grounds from damage.

In the lower gate-chamber temperature cracks in the concrete foundations have been cut out and pointed with Portland cement mortar. The brick piers supporting the 48-inch pipes in wells Nos. 2 and 3 have been repaired, and a 48-inch flanged ¼-turn in the equalizer pipe in well No. 4, which was found to be cracked, has been replaced. During the year the Anna Tucker house and barn in Boylston, and the Henry March house and barn in Oakdale, which are now occupied by employés of the Board, have been thoroughly repaired and painted. The Clinton office building has been shingled and the exterior painted.

*Sudbury Reservoir.* — At the beginning of the year the water in this reservoir stood at elevation 256.97, or 2.03 feet below the stone crest of the dam. During the winter and early spring months the water was kept for the greater part of the time from 2 to 3 feet below the crest of the dam, in order to provide storage in case of large yields from the watershed. From May 3 until December 7 the water, except for a short time in September, was flowing continuously over the crest of the dam, the elevation of the reservoir being kept at the proper height by water furnished from the Wachusett Reservoir. The flow from the Wachusett Reservoir was shut off from December 16 to 26, and at the end of the year the water in the Sudbury Reservoir was about 3 feet below the crest of the dam.

Early in the year it was found that about half of the barn at the Sudbury Dam was so badly decayed that it was unsafe for use. This portion of the barn has been rebuilt, and the whole barn and the house occupied by the foreman have been shingled. The barn was painted by our own employés.

The grounds near the dam have been improved by covering an unsightly rock dump with loam, planting two dozen swamp maples, and by sodding the steep slope of the hillside near the head-house of the Weston Aqueduct.

During the winter 81 electric railway poles and 1,425 ties were cut and sold to the Boston & Worcester Street Railway Company, and 593 chestnut posts were cut for use on the works.

When opportunity offered, some work has been done toward the construction of a rough road, 13,000 feet long, along the northerly side of the reservoir, from the dam to Parmenter Street, for use in reaching our property on the north side of the reservoir.

A four-strand twisted wire fence, 1,109 feet long, has been built, and 203 feet of stone wall repaired on the property line between land of the Commonwealth and of Robert A. Clark, who will build an equal amount of fence to complete the fencing of the line between himself and the land of the Commonwealth.

During August and September 3,200 pine trees were set out at various points around the reservoir. In the winter and early spring an inspection of all the woods belonging to the Commonwealth around the reservoir was made for gypsy and brown-tail moths. None of the former were found, but 3,500 nests of brown-tail moths were destroyed, the greater proportion of these being found in Marlborough, in the vicinity of the Marlborough filter-beds.

*Marlborough Brook Filter-beds.* — These beds have been in use throughout the year, and have filtered all the water received from the brook except for a small amount on March 10 and during a thunder-shower in the night of July 31. All of the beds have been cleaned during the year, and grass and weeds were removed from the surface of the beds about the first of August. The receiving and settling reservoir was cleaned in June, and about 1,100 cubic yards of material were removed and used for filling a depression on the easterly side of the reservoir, near Walker Street. During July and August there was a flow of tar from the reservoir of the Marlborough Gas Company into Marlborough Brook, the quantity at one time being so large as to extend down the brook for a distance of several hundred feet. The gas company removed the tar from the brook, and constructed a cut-off trench to prevent its entering the brook in the future. There was a flow of diluted sewage from the Marlborough main sewer to the combined storage reservoir and filter-bed on Farm Road during a part of March and for a few days in April, and a small flow of ground water continued through the sewer at times until the first of August.

*Framingham Reservoir No. 3.* — The water in this reservoir has been kept from 1 to 3 feet below the crest of the dam, its elevation being controlled by drafts from the Sudbury Reservoir.

*Framingham Reservoir No. 2.* — This reservoir was kept practically full throughout the year. Water for the supply of the Metropolitan District was drawn from the reservoir during portions of the months of February, May, July, September and November, and continuously during August and October.

A four-strand ribbon wire fence, about 4,000 feet long, was built in the spring on the property line between land of R. H. Long and the Commonwealth on the westerly side of the reservoir.

*Framingham Reservoir No. 1.* — This reservoir was full throughout the year except when drawn upon for the purpose of filling Farm Pond or of running water to Lake Cochituate. Water was wasted at the dam during the whole or a part of every month in the year except October. Water was drawn from this reservoir into Lake Cochituate on June 14, 15, 19, 20 and 21; from June 30 to July 2; on July 21, 22 and 23; September 4, 5, 6 and 7; November 27 and 28; and December 3, 4 and 5.

*Ashland Reservoir.* — At the beginning of the year water in this reservoir was at elevation 220.91, or 4.3 feet below high water, but water was flowing over the masonry crest of the waste-way on January 25. The reservoir remained full and water ran over the flash-boards at the waste-way until early in September, when the reservoir was drawn upon for the supply of the Metropolitan District, and on October 20 its surface had been lowered about 5 feet. In the latter part of December the reservoir was again full, and water was flowing over the crest of the waste-way.

On April 19 the upper portion of the gate-keeper's house was destroyed by fire. The house was a small, one and one-half story building, and did not properly accommodate the keeper's family. In rebuilding, another story has been added and a more convenient arrangement of the interior made. The rebuilding, with the exception of the painting, which was done by our own men, was done by A. P. Eldridge of South Framingham, at a cost of $1,200.

*Hopkinton Reservoir.* — This reservoir was 9.26 feet below high water at the beginning of the year. The water gradually rose during January and February, and on March 5 was flowing over the stone crest of the waste-way. Water was drawn from the reservoir to replenish Framingham Reservoir No. 2 during a portion of each month from May to November, excepting June. The reservoir remained full and water was running over the flash-boards a portion of the time until early in September, when the draft gradually lowered the water to 5 feet below the crest of the dam on November 6. On January 1, 1907, the water had risen to elevation 303, or 2 feet below high water.

The flight of steps leading up the side of the embankment of the

dam, opposite the filter-beds, has been repaired; and a small piece of ground between the foot of the dam and filter-bed No. 1, which was covered with water when the filter-beds were in use, has been raised, to prevent flooding.

During the winter, 1,886 chestnut posts were cut on the southerly side of the reservoir.

*Whitehall Reservoir.* — Water was allowed to run to waste from this reservoir during January and portions of February and March. The surface of the reservoir fell from elevation 337.27 on January 1 to 335.45 on February 20. Early in July the reservoir reached its old high-water mark, and remained full until the early part of December, when water was again allowed to waste. On January 1, 1907, the elevation of the reservoir was 337.05.

*Farm Pond.* — The water in this pond ranged between high-water and a foot below during the year. For the convenience of the Framingham Water Works, it was partially filled with water drawn from Framingham Reservoir No. 1 in September and November.

*Lake Cochituate.* — At the beginning of the year the water in the lake was 5.68 feet below high water. No water was drawn from the lake from January 1 until April 24, and it was so near high-water mark on March 9 that waste was commenced at the outlet dam, and continued for the greater portion of the time until April 24. The lake remained practically full until early in July, after which date it gradually lowered until the middle of November, when it was 7.6 feet below high water. Water was turned into the lake from Framingham reservoirs Nos. 1 and 2 in June, July, September, November and December.

Between October 15 and November 26 the wooden flume through the circular dam which is used for keeping the easterly arm of the lake, known as the Fiske Meadow, covered with water at times when the lake is more than 1 foot below high water, was replaced by a flume built of Portland cement concrete. The flume is 6.25 feet wide, 42.5 feet long on the bottom and 7.25 feet deep at the centre. The floor of the flume and the foundation of the sidewalls are of concrete 14 inches in thickness, reinforced with corrugated steel rods, and are supported upon the spruce piles which supported the old culvert and upon 4-inch by 4-inch spruce timbers driven through the underlying peat and mud to hard bottom. The sidewalls of the flume are 18 inches thick at the top, with a batter of about 3 inches

per foot on the back; they are 7.25 feet high at the centre and 6 inches high at either end. The slope on the down-stream side of the dam was repaved. The elevation of the water above the dam can be controlled by stop-planks set in grooves in the sidewalls of the flume. While the work on the flume was in progress considerable work was done in removing the rubbish from the shores around the basin, and at the easterly end, near West Central Street, the shore was improved by excavating so as to prevent shallow flowage.

During the early part of the year the land between the outlet dam and the attendant's house was improved by cutting out trees and underbrush which had been killed by fire during the previous year, and a few nests of the brown-tail moth were found and destroyed. In the latter part of the year the eggs of the gypsy moth were found in considerable numbers on the east side of the lake, in the neighborhood of the summer camps. The work of destroying these was begun in December.

The barn, store-house and carriage-house used by the foreman, and the roof of the effluent gate-house, have been painted.

No water has been turned from Dudley Pond into Lake Cochituate, and the elevation of the pond has ranged between 3.9 feet below high water at the beginning of the year and 2.39 feet below on June 1.

The surface of Dug Pond has varied between 0.91 of a foot above and 3 feet below the invert of the 18-inch overflow pipe.

Water was pumped on to the Pegan Brook filter-beds on 191 days during the year. The total quantity pumped was 246,525,000 gallons, of which 158,739,000 gallons were from Pegan Brook and 87,786,000 gallons from the intercepting ditch which collects water from the brooks formerly draining into Pegan Brook Meadow. The total quantity of coal consumed was 148,825 pounds, so that 1,656 gallons of water were pumped per pound of coal. The cost of operating the pumping station, cleaning the filter-beds and caring for the grounds was $4,314.79, making the cost per million gallons pumped $17.50. The filter-beds have been cleaned several times in the usual way, by the removal of the deposit which collects on the surface of the beds, and in addition the dark-colored sand composing the upper surface of the beds has been removed to an average depth of about 3 inches. The deeper portion of the receiving reservoir on Pegan Brook has also been cleaned of mud and silt, which gen-

erally had a depth of about 8 inches, except along the location of the old channel, where the depth of the deposit was about 3½ feet. About 1,027 cubic yards of sand were removed from the surface of the filter-beds, and about 2,450 cubic yards of mud and silt from the bottom of the receiving reservoir. The sill of the overflow from the receiving reservoir and the stop-plank grooves of the overflow, which were of wood, and badly decayed, have been removed and replaced by a concrete sill and grooves.

## Sources from which Water has been taken.

An average of 80,764,000 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. An average of 32,289,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 68,363,000 gallons per day, and from Framingham reservoirs Nos. 1 and 2 an average of 5,634,000 gallons per day, was drawn through the Sudbury Aqueduct to Chestnut Hill Reservoir. An average of 13,288,000 gallons per day was drawn from Lake Cochituate through the Cochituate Aqueduct to Chestnut Hill Reservoir. The Spot Pond drainage area furnished 321,000 gallons per day.

## Aqueducts.

The *Wachusett Aqueduct* has been in use 316 days during the year. It was thoroughly cleaned between December 17 and 22. It was also examined at this time and found to be in good condition. All ironwork on structures along the aqueduct, including the terminal chamber, has been painted. The granolithic surfacing on top of the Assabet Bridge has been repaired, and the usual work of maintenance along the line of the aqueduct performed.

The *Sudbury Aqueduct* has been in service 359 days during the year. The aqueduct was cleaned from Framingham Dam No. 1 to Chestnut Hill Reservoir, including the three siphon pipes, from May 22 to 24 and June 5 to 8. The joints in the masonry of several of the culverts and waste-weirs, and in the superstructures of the east and west siphon chambers, have been cut out and pointed, the work on the culverts and waste-weirs being done by our own employés and that on the siphon chambers by R. H. Pickett. Of the 50 culverts, waterways and waste-weirs on the line of this aqueduct,

28 have been repointed within the last few years and 5 have been partially pointed. The ironwork in the roofs of the east and west siphon chambers and the 4 waste-weirs has been thoroughly scraped, to remove the rust, and painted, also the floor beams and gratings of the west siphon chamber. The flash-boards in both the east and west siphon chambers, 161 in number, were painted, also two small buildings over manholes on the line of the aqueduct.

In order to avoid possible claims for damages on account of the running of water from the Sudbury Aqueduct through Course Brook to Lake Cochituate, the right has been obtained from John West, the owner of a parcel of land through which the brook runs, to flood his land to a height not exceeding elevation 150.20 at the culvert under Speen Street, also the right to enter his land for the purpose of repairing or deepening the brook.

The Newton and Watertown Gas Light Company laid eight 3-inch pipes over the aqueduct, under the sidewalk on the easterly side of Walnut Street, and the New England Telephone and Telegraph Company and the Newton and Watertown Gas Light Company laid 3-inch and 8-inch pipes over the aqueduct on Boylston Street at Newton Upper Falls. The town of Needham laid a 4-inch water pipe over the aqueduct at Wellesley Avenue.

Early in the year about 350 nests of the brown-tail moth were destroyed along the line of the aqueduct between the west siphon chamber and the westerly end of the Beacon Street tunnel.

The *Cochituate Aqueduct* was in use 237 days. The aqueduct was cleaned during the month of April. The stone masonry of two of the culverts has been repointed. The surveys for locating the aqueduct and determining the position of property bounds, which have been in progress for several years, have been finished. During the year 73 alignment bounds and 195 land bounds have been set, and at the end of the year but 36 of the property bounds remained to be set to complete the work.

The Newton and Watertown Gas Light Company laid eight 3-inch pipes over the aqueduct at Walnut Street in Newton Centre.

About 8,600 nests of the brown-tail moth were destroyed along the line of the aqueduct between the waste-weir in Wellesley and Chestnut Hill Reservoir, and 170 clusters of the eggs of the gypsy moth were destroyed on the aqueduct line in Newton and Brighton.

Beginning at a point about 850 feet east of the road leading from Cochituate to Natick, and extending for a distance of about a mile,

the land through which the aqueduct runs is wet and swampy. This has been improved by the construction of a ditch 1,550 feet long, 12 inches wide at the bottom and 1½ to 2 feet deep, with side slopes of 2½ to 1, draining westerly into Snake Brook, and by a similar but somewhat smaller ditch, 1,450 feet long, which carries the surface water easterly toward Oak Street into Stevens Brook.

The *Weston Aqueduct* was in use 355 days. It was cleaned from the head-house to siphon chamber No. 4 between March 6 and 17, including the siphon pipes at the Sudbury River and Happy Hollow. Two screens have been made and set in the head-house. In order to keep cattle off the aqueduct embankments, 2,265 feet of 4-strand ribbon wire fence has been built on the property line opposite lands of Bullard and Thomas in Wayland, and 704 feet along the line of Water Street in Framingham. The interior and exterior woodwork of the head-house, meter chamber, 2 gaging chambers and 4 siphon chambers has been painted. During the early winter months a portion of the woodland near siphon chambers Nos. 1 and 2 was improved by cutting underbrush and dead trees, and by thinning out the trees so that the remainder may have a better opportunity to grow. In doing this work 320 chestnut fence posts and about 19 cords of wood were obtained. Quite a number of small trees and considerable underbrush have also been cut along the aqueduct line, for the purpose of saving future expense in protecting the property from the gypsy and brown-tail moths. The trees along the whole length of the aqueduct have been inspected for moths, and both varieties have been found and destroyed in small numbers at different points between the terminal chamber in Weston and the easterly end of tunnel No. 2 in Framingham. In the latter part of November work was begun on a small barn, 20 feet by 30 feet, to be built on the land formerly owned by George A. White, which is to be used by the foreman in charge of the aqueduct line. It is to be built by our regular employés during the winter.

## Pumping Stations.

Seventy-three per cent. of all the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir; the remainder was delivered by gravity. The total quantity pumped at all of the stations during the year was 35,180,570,000 gallons, or 805,660,000 gallons less than during the preceding year. The cost of operating the stations was $102,377.95, equivalent to

$2.91 per million gallons pumped, or $0.30 per million gallons more than the corresponding cost during the year 1905.

The cost per gross ton of fuel used at the Chestnut Hill high-service station was $0.08 greater, at the Chestnut Hill low-service station $0.04 greater, and at the Spot Pond station $0.36 greater, than during the preceding year. The greater part of the increase in cost of pumping is due to the increased cost of labor, caused both by increase in the rate of wages paid and by increase in the number of employés during the last two months of the year, made necessary by a reduction in the hours of labor from 56 hours to 48 hours per week. The remainder of the increase is due to increase in the cost of fuel, and a slight decrease in the efficiency of the pumping machinery.

Tests have been made from time to time to determine the viscosity, specific gravity and burning point of oil used at the several stations, and tests have been made to determine the calorific value of coal used and offered for use in the several stations. Twenty-four tests have been made of oil and 33 of coal.

Coal for use at the several stations has been purchased as follows: —

| | Gross Tons. | | | | | Price per Gross Ton, in Bins. |
|---|---|---|---|---|---|---|
| | Chestnut Hill High-service Station. | Chestnut Hill Low-service Station. | Spot Pond Station. | West Roxbury Station. | Arlington Station. | |
| Merchants Coal Company, bituminous, . | 178.60 | - | - | - | - | $4 79 |
| C. W. Claflin & Co., bituminous, . . | 410.50 | - | - | - | - | 4 73 |
| Merchants Coal Company, bituminous, . | 196.39 | - | - | - | - | 4 56 |
| Merchants Coal Company, bituminous, . | 518.99 | - | - | - | - | 4 48 |
| Merchants Coal Company, bituminous, . | - | 796.07 | - | - | - | 4 42 |
| Spring Coal Company, bituminous, . | 53.26 | - | - | - | - | 4 15 |
| William A. Jepson, bituminous, . . | 2,004.20 | - | - | - | - | 4 14 |
| Anderson Coal Mining Company, bituminous. | 45.81 | - | - | - | - | 4 10 |
| Merchants Coal Company, bituminous, . | 1,371.30 | - | - | - | - | 4 09 |
| William A. Jepson, bituminous, . . | - | 1,379.69 | - | - | - | 4 05 |
| Merchants Coal Company, bituminous, . | - | 1,061.86 | - | - | - | 4 00 |
| C. W. Claflin & Co , buckwheat anthracite. | 1,230.70 | - | - | - | - | 2 93 |
| C. W. Claflin & Co., buckwheat anthracite. | - | 1,061.80 | - | - | - | 2 84 |
| Bay State Fuel Company, screenings, . | 58.23 | - | - | - | - | 2 52 |
| Bay State Fuel Company, screenings, . | - | 3.42 | - | - | - | 2 52 |
| Malden Coal Company, bituminous, . | - | - | 305.90 | - | - | 4 33 |

| | Gross Tons. | | | | | Price per Gross Ton, in Bins. |
|---|---|---|---|---|---|---|
| | Chestnut Hill High-service Station. | Chestnut Hill Low-service Station. | Spot Pond Station. | West Roxbury Station. | Arlington Station. | |
| Locke Coal Company, bituminous, . | - | - | 447.91 | - | - | $4 35 |
| Locke Coal Company, screenings, . . | - | - | 277.39 | - | - | 2 24 |
| D. J. Cutter & Co., anthracite, . . | - | - | - | 363.37 | - | 7 28 |
| Locke Coal Company, bituminous, . | - | - | - | - | 50.01 | 4 69 |
| Peirce & Winn Company, bituminous, . | - | - | - | - | 113.54 | 4 51 |
| Locke Coal Company, bituminous, . | - | - | - | - | 285.00 | 4 48 |
| Wellington-Wild Coal Co., bituminous, | - | - | - | - | 51.49 | 4 25 |
| Peirce & Winn Company, screenings, . | - | - | - | - | 193.24 | 2 24 |
| Locke Coal Company, screenings, . . | - | - | - | - | 6.35 | 2 24 |
| Total gross tons, bituminous, . . | 4,774.05 | 3,237.62 | 753.81 | - | 500.04 | - |
| Total gross tons, anthracite, . . | 1,230.70[1] | 1,061.80[1] | - | 363.37 | - | - |
| Total gross tons, anthracite screenings. | 58.23 | 3.42 | 277.39 | - | 199.59 | - |
| Average price per gross ton, bituminous, | $4 26 | $4 12 | $4 36 | - | $4 48 | - |
| Average price per gross ton, anthracite, | 2 93[1] | 2 84[1] | - | $7 28 | - | - |
| Average price per gross ton, anthracite screenings. | 2 52 | 2 52 | 2 24 | - | 2 24 | - |

[1] Buckwheat.

*Chestnut Hill High-service Station.*

The water used in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton, was pumped at this station.

The following are the statistics relating to operations at this station: —

| | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. | Totals for Station. |
|---|---|---|---|---|
| Total quantity pumped (million gallons), . . . . | 1,905.11 | 514.22 | 10,310.81 | 12,730.14 |
| Daily average quantity pumped (gallons), . . | 5,219,000 | 1,409,000 | 28,249,000 | 34,877,000 |
| Total coal used (pounds), . . . . . . . . | 3,014,777 | 518,933 | 8,518,537 | 12,052,247 |
| Gallons pumped per pound of coal, . . . . . | 631.92 | 990.91 | 1,210.40 | 1,056.25 |
| Average head pumped against (feet), . . . | 120.99 | 128.44 | 131.57 | 129.36 |
| Cost of pumping: — | | | | |
| Labor, . . . . . . . . . . . . . . | $4,945 02 | $608 62 | $13,465 67 | $19,019 31 |
| Fuel, . . . . . . . . . . . . . . | 5,415 43 | 908 63 | 15,253 44 | 21,577 50 |
| Repairs, . . . . . . . . . . . . . | 2,000 35 | 246 22 | 509 36 | 2,755 93 |
| Oil, waste and packing, . . . . . . . . | 141 58 | 17 43 | 385 53 | 544 54 |
| Small supplies, . . . . . . . . . . | 144 53 | 17 79 | 393 55 | 555 87 |
| Totals, . . . . . . . . . . . . | $12,646 91 | $1,798 69 | $30,007 55 | $44,453 15 |
| Cost per million gallons pumped, . . . . . | $6.638 | $3.498 | $2.910 | $3.492 |
| Cost per million gallons raised 1 foot high, . . | 0.055 | 0.027 | 0.022 | 0.027 |

The repairs on engine No. 2, which were in progress at the beginning of the year, were completed in February, and the engine was placed in service on the 19th of that month. A description of the work done was given in the report for the year 1905.

Plans and specifications have been prepared and a contract will soon be made for an additional boiler of the same size and design as the two 64-inch horizontal tubular boilers now in use at the station.

The joints in the exterior masonry of the pumping station have been repointed.

*Chestnut Hill Low-service Pumping Station.*

The quantity of water pumped at this station was about 5 per cent. less than during the preceding year.

The following are the statistics relating to operations at this station: —

| | Engines Nos. 5, 6 and 7. |
|---|---|
| Total quantity pumped (million gallons), | 18,938.59 |
| Daily average quantity pumped (gallons), | 51,887,000 |
| Total coal used (pounds), | 7,955,358 |
| Gallons pumped per pound of coal, | 2,380.61 |
| Average head pumped against (feet), | 51.15 |
| Cost of pumping: — | |
| Labor, | $16,754 78 |
| Fuel, | 13,583 83 |
| Repairs, | 682 68 |
| Oil, waste and packing, | 535 07 |
| Small supplies, | 448 60 |
| Total for station, | $32,004 96 |
| Cost per million gallons pumped, | $1.690 |
| Cost per million gallons raised 1 foot high, | 0.033 |

The cost per million gallons pumped was $0.106 greater than for the year 1905. This was due to the increase in the cost of labor and fuel.

*Spot Pond Pumping Station.*

At this station practically all of the water was pumped with engine No. 9, the 20,000,000-gallon Holly engine, engine No. 8 having been in operation only 12 hours and 45 minutes during the year.

The following are the statistics relating to operations at this station: —

| | Totals for Station. Engines Nos. 8 and 9. |
|---|---|
| Total quantity pumped (million gallons), | 3,031.77 |
| Daily average quantity pumped (gallons), | 8,306,000 |
| Total coal used (pounds), | 2,533,049 |
| Gallons pumped per pound of coal, | 1,196.09 |
| Average head pumped against (feet), | 127.98 |
| Cost of pumping: — | |
| Labor, | $6,771 54 |
| Fuel, | 4,485 18 |
| Repairs, | 462 26 |
| Oil, waste and packing, | 174 97 |
| Small supplies, | 311 09 |
| Totals, | $12,205 04 |
| Cost per million gallons pumped, | $4.026 |
| Cost per million gallons raised 1 foot high, | 0.031 |

The cost per million gallons pumped was $0.078 more than for the previous year, due, as at the Chestnut Hill stations, to the increased cost of labor and fuel.

Joints in the exterior masonry of the building were repointed, and repairs made upon the tile roof and copper gutters.

### *West Roxbury Pumping Station.*

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station: —

Pumps operated 7,892 hours 5 minutes; average, 22 hours per day.

| | |
|---|---|
| Daily average quantity of water pumped (gallons), | 646,000 |
| Daily average quantity of coal consumed (pounds), | 2,238 |
| Gallons pumped per pound of coal, | 289 |
| Average lift in feet, | 140 |
| Cost of pumping: — | |
| Labor, | $3,817 81 |
| Fuel, | 2,659 72 |
| Repairs and small supplies, | 667 26 |
| Total for station, | $7,144 79 |
| Cost per million gallons pumped, | $30.281 |
| Cost per million gallons raised 1 foot high, | 0.216 |

During the first seven months of the year the quantity of water consumed in the district supplied from this station showed a considerable increase, and during several weeks the daily average quantity pumped was between 800,000 and 900,000 gallons per day. The discovery and repair of a number of leaks in the distribution system, one of which amounted to about 108,000 gallons per day, caused a very material reduction in the quantity pumped, and at the close of the year the daily average quantity of water pumped was less than 500,000 gallons.

One of the 54-inch vertical boilers was repaired by putting in new tube sheets, the work being done by the Daniel Russell Boiler Works of South Boston, at a cost of $175. A new Warren air pump was installed in April as an auxiliary to the old air pump, which did not work satisfactorily, and which is now held in reserve. In March a new plunger rod was placed in the No. 2 pump, to replace one which broke while the pump was in operation.

### *Arlington Pumping Station.*

All water supplied to the town of Lexington and to the high-service district of Arlington was pumped at this station.

The following are the statistics relating to operations at this station: —

Pumps operated 8,702 hours 45 minutes; average, 24 hours per day.

| | |
|---|---|
| Daily average quantity of water pumped (gallons), | 671,000 |
| Daily average quantity of coal consumed (pounds), | 4,055 |
| Gallons pumped per pound of coal, | 165 |
| Average lift in feet, | 283 |

| | |
|---|---|
| Cost of pumping: — | |
| Labor, | $3,620 78 |
| Fuel, | 2,670 38 |
| Repairs and small supplies, | 278 85 |
| Total for station, | $6,570 01 |

| | |
|---|---|
| Cost per million gallons pumped, | $26.843 |
| Cost per million gallons raised 1 foot high, | 0.095 |

The quantity pumped was 86,000 gallons per day, or 14.7 per cent. greater than during the year 1905. The cost per million gallons pumped was $0.28 less than during the previous year, due to the increase in the amount of water pumped, while the cost of operation did not increase in the same proportion.

On October 3 the cast-iron partition between the water cylinders in the compound Blake pump, which is constantly used for pumping at this station, was found to be cracked. Temporary repairs were made by our own employés, which it is expected will permit the use of the pump until the engine in the new station which is now being built is placed in service.

## Consumption of Water.

The daily average quantity of water consumed in the cities and towns supplied from the Metropolitan Water Works during the year 1906, as measured by the Venturi meters, was 117,524,600 gallons, equal to 128 gallons per inhabitant in the district supplied. In addition to the above, 45,000 gallons daily were supplied to the United States Government reservation on Peddock's Island. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct and the estimated yield of Spot Pond, was 118,820,000 gallons, equal to 130 gallons per inhabitant. The excess difference of 1,250,400 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to differences in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1905 and 1906, as measured by the Venturi meters, was as follows: —

| | Estimated Population. 1906. | Daily Average Consumption. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1905. | | 1906. | | | |
| | | Gallons. | Gallons per Capita. | Gallons. | Gallons per Capita. | Increase. | Decrease. |
| Boston, . . | 601,430 | 89,743,900 | 151 | 90,951,800 | 151 | 1,207,900 | - |
| Somerville, . . | 70,950 | 6,160,900 | 89 | 6,301,000 | 89 | 140,100 | - |
| Malden, . . | 39,040 | 2,019,500 | 53 | 2,000,100 | 51 | - | 19,400 |
| Chelsea, . . | 38,000 | 4,091,200 | 110 | 3,694,000 | 97 | - | 397,200 |
| Everett, . . | 30,270 | 2,592,400 | 89 | 2,441,600 | 81 | - | 150,800 |
| Quincy, . . | 28,300 | 3,050,100 | 109 | 3,021,800 | 107 | - | 28,300 |
| Medford, . . | 20,080 | 1,921,800 | 97 | 2,014,100 | 100 | 92,300 | - |
| Melrose, . . | 14,650 | 1,601,100 | 112 | 1,591,300 | 109 | - | 9,800 |

| | Estimated Population. 1906. | Daily Average Consumption. 1905. Gallons. | 1905. Gallons per Capita. | 1906. Gallons. | 1906. Gallons per Capita. | Increase. | Decrease. |
|---|---|---|---|---|---|---|---|
| Revere, . . | 13,390 | 1,006,800 | 78 | 1,093,200 | 82 | 86,400 | - |
| Watertown, . | 11,550 | 790,700 | 70 | 771,300 | 67 | - | 19,400 |
| Arlington, . . | 9,940 | 787,700 | 81 | 800,800 | 81 | 13,100 | - |
| Milton, . . | 7,120 | 320,900 | 45 | 350,300 | 49 | 29,400 | - |
| Winthrop, . . | 7,240 | 798,300 | 113 | 819,800 | 113 | 21,500 | - |
| Stoneham, . . | 6,350 | 514,000 | 81 | 441,200 | 69 | - | 72,800 |
| Belmont, . . | 4,410 | 266,300 | 61 | 272,900 | 62 | 6,600 | - |
| Lexington, . . | 4,230 | 299,100 | 74 | 335,000 | 79 | 35,900 | - |
| Nahant, . . | 1,850 | 136,600 | 74 | 131,900 | 71 | - | 4,700 |
| Swampscott, . | 6,240 | 534,600 | 88 | 492,500 | 79 | - | 42,100 |
| District, . | 915,040 | 116,635,900 | 129 | 117,524,600 | 128 | 888,700 | - |

The consumption in the several districts was as follows: —

| | Gallons per Day. | Increase (Gallons per Day). |
|---|---|---|
| Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, . . . . . . | 47,769,800 | 665,800 |
| Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, . . . . . . . . . . . . . . . . . . | 26,258,200 | 750,800 [1] |
| Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, Belmont, and a portion of Milton, . . . . . . | 33,870,300 | 739,400 |
| Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, . . . . . . | 8,309,300 | 137,300 |
| Southern extra high-service district, embracing the highest portions of West Roxbury and Milton, . . . . . . . . . . . . . . . | 646,400 | 10,400 |
| Northern extra high-service district, embracing Lexington and the highest portions of Arlington, . . . . . . . . . . . . . . | 670,600 | 85,600 |
| Totals, . . . . . . . . . . . . . . . . . . | 117,524,600 | 888,700 |

[1] Decrease.

The consumption in the northern low-service district shows a reduction, while all the other districts show an increase, as compared with the quantity used in 1905. This is due to the fact that in Chelsea, East Boston and Somerville, which form a considerable part of the northern low-service district, the waste to prevent freezing of service pipes during the cold months in 1905 was greater in

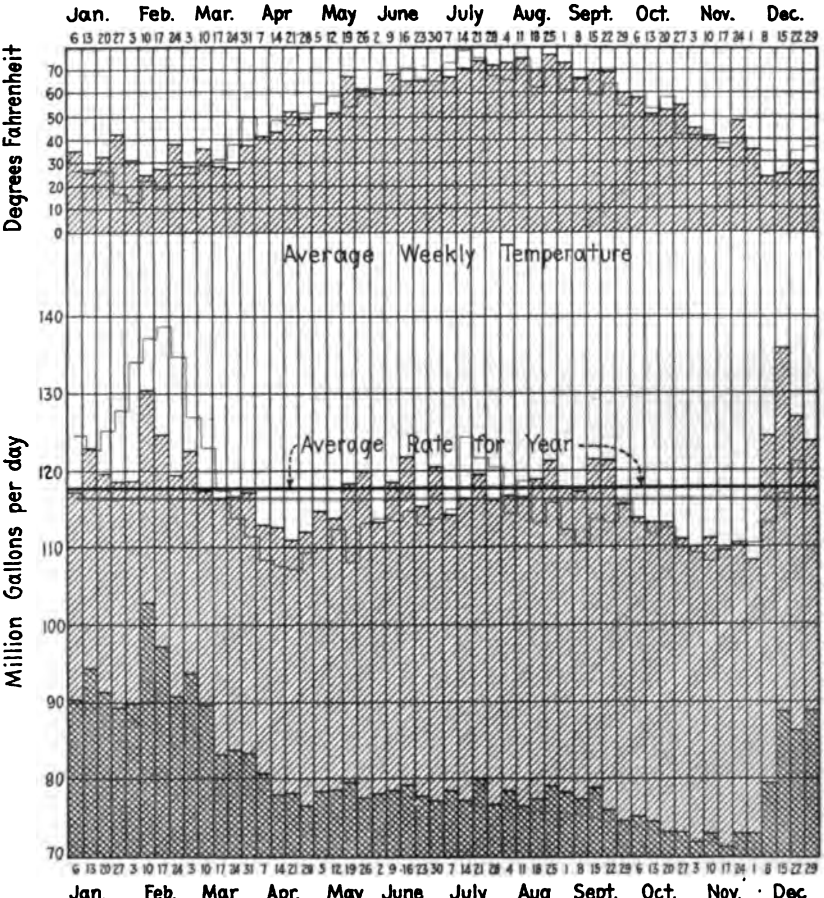
proportion to the total consumption for that year than in any other parts of the Metropolitan District.

The diagram facing this page shows the average rate of consumption in the district supplied by the Metropolitan works for each week during the years 1905 and 1906, also the rate of consumption between the hours of 1 and 4 A.M., and the average temperature of the air for the week. By examination of the diagram it will be seen that during the months of January, February and March, 1906, the consumption was smaller during the past year than during 1905, while during the month of December it was larger during the latter year. These variations in the consumption were largely due to difference in temperature, the earlier months having been much warmer and the last month colder in 1906 than in 1905. The diagram also shows a noticeable drop in the night rate, not only during the winter months but also during the latter half of the year 1906, which appears to indicate that the increasing use of meters in some cities and towns and more careful inspection for leaks are causing a reduction in the quantity of water which is being wasted.

During the latter portion of the year a very noticeable reduction was made in the consumption of the district in West Roxbury, which is supplied with water from the West Roxbury pumping station. This reduction was due to the inspection made by the Boston authorities and the discovery and repair of a large leak in a 12-inch main on Corey Street, together with two leaks in service pipes and numerous defects in house plumbing. The leak from the 12-inch main, due to the blowing out of a leaded joint, caused a waste of about 4,500 gallons per hour, or 108,000 gallons per day, which ran into an old well and disappeared. A reduction of about 200,000 gallons per day, equivalent to about 25 per cent. of the total consumption of the district, was made by the discovery and repair of these defects.

The number of new meters set during the past year in the cities and towns supplied from the Metropolitan Works was 4,257, — a greater number than have been set during any year since the Metropolitan Water Works have been in operation, and about 1,000 more than the number of new services laid. The greater number of the meters were set in Malden, Somerville, Quincy, Swampscott and Chelsea.

AVERAGE RATE OF CONSUMPTION
IN
METROPOLITAN WATER DISTRICT
AND
Average Temperature of Air at Chestnut Hill Reservoir
FOR
Each Week during 1906




Average Rate of Consumption for each week, thus
" " " " between 1 and 4 A.M. for each week, thus
Average Rate of Consumption in 1905 shown in red

## Quality of the Water.

Samples of water have been collected every two months from 15 points, and monthly from 8 points on the works, and sent to the State Board of Health for analysis and examination. Samples of water have also been collected weekly at 24 points, biweekly at 7 points and monthly at 14 points, and examined microscopically and for color, odor, taste and turbidity in the biological laboratory of the Metropolitan Water and Sewerage Board, which has been in charge of Arthur W. Walker.

The quality of the water delivered in the Metropolitan District has been substantially the same as during the past three or four years, except that the number of microscopic organisms has been somewhat larger and the color of the water somewhat less.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1900 to 1906, inclusive: —

| | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. |
|---|---|---|---|---|---|---|---|
| *State Board of Health Examinations.* | | | | | | | |
| Color (Nessler standard), | 0.24 | 0.24 | 0.26 | 0.25 | 0.23 [1] | 0.24 [1] | 0.24 [1] |
| Total residue, | 3.80 | 4.43 | 3.93 | 3.96 | 3.98 | 3.86 | 3.86 |
| Loss on ignition, | 1.20 | 1.64 | 1.56 | 1.50 | 1.59 | 1.59 | 1.39 |
| Free ammonia, | 0.0012 | 0.0013 | 0.0016 | 0.0013 | 0.0023 | 0.0020 | 0.0018 |
| Albuminoid ammonia, total, | 0.0157 | 0.0158 | 0.0139 | 0.0125 | 0.0139 | 0.0145 | 0.0159 |
| Albuminoid ammonia, dissolved, | 0.0138 | 0.0143 | 0.0119 | 0.0110 | 0.0121 | 0.0124 | 0.0134 |
| Albuminoid ammonia, suspended, | 0.0019 | 0.0015 | 0.0020 | 0.0015 | 0.0018 | 0.0021 | 0.0025 |
| Chlorine, | 0.25 | 0.30 | 0.29 | 0.30 | 0.34 | 0.35 | 0.34 |
| Nitrogen as nitrates, | 0.0076 | 0.0173 | 0.0092 | 0.0142 | 0.0110 | 0.0083 | 0.0054 |
| Nitrogen as nitrites, | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Oxygen consumed, | 0.38 | 0.42 | 0.40 | 0.39 | 0.37 | 0.35 | 0.36 |
| Hardness, | 1.3 | 1.7 | 1.3 | 1.5 | 1.5 | 1.4 | 1.3 |
| *Metropolitan Water and Sewerage Board Examinations.* | | | | | | | |
| Color (platinum standard), | 34 | 34 | 33 | 35 | 32 | 28 | 25 |
| Turbidity, | - | 2.0 | 2.3 | 2.2 | 2.4 | 1.9 | 2.2 |
| Total organisms, | 468 | 243 | 367 | 286 | 303 | 528 | 550 |
| Amorphous matter, | 97 | 38 | 34 | 36 | 36 | 37 | 42 |
| Bacteria, | 181 | 162 | 164 | 126 | 176 | 231 | 154 |

Note. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

The color of the water supplied in the northern high-service district is, by storage in the Spot Pond and Fells reservoirs, reduced to about two-thirds that of the water supplied to the remainder of the Metropolitan District.

In the biological laboratory there have been made 2,526 microscopical and 1,017 biological examinations of water collected at various points on the works. Of the microscopical examinations, 1,967 were of the regular weekly and biweekly samples, and 559 were special examinations.

The bacteriological work consisted of routine weekly examinations, the monthly examinations of the main feeders of the Sudbury Reservoir, of Framingham Reservoir No. 3 and of Lake Cochituate, and monthly tests of the efficiency of the Pegan and Marlborough Brook filters.

In the Wachusett Reservoir the number of organisms has been small throughout the year, and never of a character to give the water an objectionable taste or odor. In the Sudbury Reservoir the number of organisms has been much larger than usual, and from March until July Uroglena was present in varying quantities, causing at times an objectionable odor in the water of the reservoir. The organisms were broken up by passing the water over the Sudbury Dam, and both organisms and odor disappeared before the water reached the gate-house at the lower end of Framingham Reservoir No. 3. In Lake Cochituate the number of microscopic organisms has been large, and at times of an objectionable character. From January 1 until April 23 no water was drawn from these sources, on account of the objectionable odor due to the growth of Chlamydomonas. Synura was present at different times during the year, but not in large enough quantities to cause trouble until December, when the odor of the water became so objectionable as to cause its use to be discontinued on December 17. The water in Spot Pond has been generally free from objectionable organisms, but there was a growth of Uroglena in April, which necessitated the shutting off of the reservoir from the distribution system from April 30 to May 11.

## Sanitary Inspection.

The sanitary inspection of the Wachusett, Sudbury and Cochituate watersheds has been continued during the year under the direction of William W. Locke, C.E., Sanitary Inspector.

On the Wachusett watershed 11 cases of typhoid fever were reported, 4 in Holden, 1 in Rutland and 6 in Princeton. Five of the cases in Princeton occurred in one house, and an analysis of the

well water indicated that it was polluted from a privy or cesspool, both of which are very near the well.

On the Sudbury and Cochituate watersheds the number of typhoid fever cases reported was 44, — a much larger number than usual. Twenty-three of these cases were reported from houses connected with the public sewers. Ten cases were reported in Marlborough, 16 in Natick, 8 in South Framingham, 2 in Ashland, 2 in Southborough, 2 in Hopkinton, 3 in Westborough and 1 in Cochituate. The cases in Marlborough were scattered throughout the city, and spread over the entire year. Nearly all of the cases in Natick and the 2 cases in Westborough were doubtless due to an infected milk supply, which caused an epidemic in South Natick. All of the cases were investigated as soon as reported, and precautions taken wherever necessary to prevent infection of the water supply.

During the year the sanitary conditions upon the several watersheds have been improved as follows: On the Wachusett watershed 30 dwelling-houses, 10 barns and 1 store on property owned by the Board have been torn down or removed outside the watershed. The Dorr and Warfield mills on the Quinepoxet River, where 50 men were formerly employed in manufacturing satinets and shoddy, have been dismantled. The land on the southerly shore of West Waushacum Pond has been acquired for a distance of about 3,000 feet, including a farmhouse and barn and 5 summer cottages. Twenty-eight cesspools, 7 cemented vaults and 1 gravel filter-bed have been built in Boylston, West Boylston and Holden, for the purpose of preventing 44 cases of unsatisfactory drainage on 31 premises from entering the streams which run into the Wachusett Reservoir.

On the Sudbury watershed 141 old and 13 new premises were connected with the public sewers which convey the drainage outside the watershed. Forty-five of these premises are in Marlborough, 98 in Westborough and 11 in Framingham. The sanitary condition at the Cordaville Mills in Ashland is now being improved by the substitution of water-closets and a sub-surface filtration plant for the privy stacks and boxes heretofore used. At the Whitehall Reservoir a more thorough inspection has been maintained to prevent bathing, and measures have been adopted tending toward the restriction of boating.

On the Cochituate watershed 51 old and 24 new premises were connected with sewers which convey the drainage outside the watershed. Twenty-four of these were in Framingham and 51 in Natick.

The sanitary conditions around Lake Cochituate have been improved by the restriction of boating. The use of boats on the northern section of the lake, from which the supply is directly drawn, has been prohibited, and the number of boats used on the other sections of the lake has been limited. All boats have been registered and numbered and their use confined to persons licensed by the Board. Two inspectors were constantly employed during the summer season, to see that the regulations affecting the use of boats were obeyed, and that the sanitary rules and regulations were obeyed by the occupants of the cottages and by other persons camping near the lake. The restriction of boating caused a considerable reduction in the number of persons camping, particularly those occupying tents and temporary camps.

A summary of the work of sanitary inspection for the year 1906 is given in the following four tables. The first table shows for the Wachusett watershed the number of premises inspected, the classification of cases inspected, and the condition of the premises at the end of the year; the second table gives the corresponding information for the Sudbury and Cochituate watersheds; the third table shows the improvements effected on the Wachusett watershed; and the fourth table the improvements effected on the Sudbury and Cochituate watersheds.

The headings of these tables explain themselves, except in a few instances: under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading "Unsatisfactory" are included all cases where there may be, under the most unfavorable conditions, wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering feeders, even though there may be some attempt at previous purification.

In the third and fourth tables no cases are entered as remedied unless complete sewer connections have been made, or all probability of future contamination has been removed; and no cases are entered as partly remedied except where positive improvement in the sanitary condition has been effected.

*Summary of Sanitary Inspections on the Wachusett Watershed in 1906.*

| District. | Number of Premises inspected.[1] | Classification of Cases inspected. | | | | | | | | | Condition at End of Year. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cesspools dug before 1906. | Cesspools dug in 1906. | Direct Privy Drainage. | Indirect Privy Drainage. | Direct Sink Drainage. | Indirect Sink Drainage. | Manure Piles. | Manufacturing Wastes. | Premises Vacant. | Satisfactory. | Unsatisfactory. |
| French Brook, | 73 | 28 | 5 | - | - | - | 11 | 32 | - | 12 | 67 | 6 |
| Muddy Brook, | 32 | 9 | - | - | - | - | 7 | 24 | - | - | 32 | - |
| Gates Brook, | 132 | 77 | 12 | - | - | - | 4 | 58 | - | 5 | 131 | 1 |
| Malden Brook, | 17 | 7 | 2 | - | - | - | - | 13 | - | 2 | 17 | - |
| Chaffin Brook, | 154 | 55 | 17 | - | - | - | 12 | 77 | 1 | 11 | 143 | 11 |
| Asnebumskit Brook, | 277 | 124 | 24 | 5 | 10 | 27 | 24 | 97 | 3 | 10 | 231 | 46 |
| Muschopauge, | 95 | 24 | 2 | - | 6 | 7 | 10 | 52 | 1 | 7 | 78 | 17 |
| South Wachusett Brook, | 82 | 21 | 1 | 2 | 1 | 4 | 3 | 36 | - | 10 | 74 | 8 |
| Trout Brook, | 38 | 5 | - | - | - | - | 3 | 26 | - | 5 | 36 | 2 |
| East Wachusett Brook, | 210 | 59 | 3 | 2 | 7 | 7 | 23 | 109 | - | 6 | 186 | 24 |
| Stillwater River, | 149 | 44 | 2 | - | 6 | 2 | 11 | 85 | - | 7 | 133 | 16 |
| Waushacum, | 163[2] | 42 | 1 | 4 | 9 | 17 | 20 | 67 | - | 8 | 124 | 39 |
| French Hill, | 28 | 14 | 1 | - | - | - | - | 15 | - | 5 | 28 | - |
| Totals, | 1,450 | 509 | 70 | 13 | 39 | 64 | 128 | 691 | 5 | 88 | 1,280 | 170 |

[1] On some premises there are 2 or more cases.
[2] Not including 207 summer cottages located near the Waushacum Lakes.

*Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1906.*

| District. | Number of Premises inspected.[1] | Classification of Cases inspected. | | | | | | | | | Condition at End of Year. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cesspools dug before 1906. | Cesspools dug in 1906. | Direct Privy Drainage. | Indirect Privy Drainage. | Direct Sink Drainage. | Indirect Sink Drainage. | Manure Piles. | Manufacturing Wastes. | Premises Vacant. | Satisfactory. | Unsatisfactory. |
| *Sudbury Watershed.* | | | | | | | | | | | | |
| Farm Pond, | 242 | 19 | - | - | - | - | 1 | 21 | - | 5 | 240 | 2 |
| Framingham Reservoir No. 3, | 71 | 32 | 1 | - | - | - | 35 | 49 | - | 2 | 66 | 5 |
| Stony Brook, | 288 | 201 | 2 | - | 3 | 2 | 48 | 113 | - | 17 | 269 | 19 |
| Angle Brook, | 1,973 | 318 | - | - | 4 | 8 | 152 | 251 | 1 | 66 | 1,889 | 84 |
| Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook, | 271 | 96 | 3 | - | 2 | - | 108 | 113 | - | 27 | 259 | 12 |

[1] On some premises there are 2 or more cases.

*Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1906* — Concluded.

| District. | Number of Premises inspected.[1] | Classification of Cases inspected. | | | | | | | | | Condition at End of Year. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cesspools dug before 1906. | Cesspools dug in 1906. | Direct Privy Drainage. | Indirect Privy Drainage. | Direct Sink Drainage. | Indirect Sink Drainage. | Manure Piles. | Manufacturing Wastes. | Premises Vacant. | Satisfactory. | Unsatisfactory. |
| Eastern Sudbury, | 239 | 201 | 3 | - | 2 | - | 47 | 43 | 2 | 6 | 225 | 14 |
| Indian Brook, | 420 | 168 | 1 | - | 2 | 7 | 170 | 83 | - | 62 | 386 | 34 |
| Western Sudbury, | 184 | 61 | 2 | - | 4 | 5 | 77 | 54 | 1 | 30 | 155 | 29 |
| Whitehall Reservoir, | 111 | 22 | - | - | 1 | 1 | 74 | 37 | - | 10 | 100 | 11 |
| Cedar Swamp, | 811 | 258 | - | - | 1 | 6 | 92 | 128 | 1 | 55 | 793 | 18 |
| *Cochituate Watershed.* | | | | | | | | | | | | |
| Snake Brook, | 320 | 219 | 2 | - | - | 2 | 93 | 68 | - | 8 | 296 | 24 |
| Pegan Brook, | 916 | 271 | 3 | - | 3 | 4 | 77 | 110 | 1 | 29 | 887 | 29 |
| Course Brook, | 88 | 49 | - | - | - | - | 29 | 41 | - | 7 | 86 | 2 |
| Beaver Dam Brook, | 1,069 | 208 | 9 | - | 4 | 3 | 90 | 183 | 3 | 16 | 1,020 | 49 |
| Dug Pond, | 499 | 191 | 1 | - | 3 | 7 | 36 | 49 | - | 8 | 477 | 22 |
| Totals, | 7,502 | 2,814 | 27 | - | 29 | 45 | 1,129 | 1,343 | 9 | 348 | 7,148 | 354 |

[1] On some premises there are 2 or more cases.

*Sanitary Improvements effected on the Wachusett Watershed in 1906.*

| District. | Remedied by Filter-bed. | Otherwise remedied.[1] | Partly remedied. |
|---|---|---|---|
| French Brook, | - | 10 | 6 |
| Muddy Brook, | 5 | - | - |
| Gates Brook, | - | 10 | 9 |
| Malden Brook, | - | - | 1 |
| Chaffin Brook, | - | 7 | 13 |
| Asnebumskit Brook, | - | 1 | 8 |
| Muschopauge, | - | - | 2 |
| South Wachusett Brook, | - | - | - |
| Trout Brook, | - | 10 | - |
| East Wachusett Brook, | - | - | - |
| Stillwater River, | - | 14 | - |
| Waushacum, | - | 1 | - |
| French Hill, | - | 4 | - |
| Totals, | 5 | 57 | 39 |

[1] Including buildings torn down or removed.

*Sanitary Improvements effected on the Sudbury and Cochituate Watersheds in 1906.*

| DISTRICT. | Remedied by Sewer Connection. | Otherwise remedied [1] | Partly remedied. | Cesspools abandoned on Account of Sewer Connections. |
|---|---|---|---|---|
| *Sudbury Watershed.* | | | | |
| Farm Pond, | 6 | - | - | 4 |
| Framingham Reservoir No 3, | - | 1 | 1 | - |
| Stony Brook, | - | - | 2 | - |
| Angle Brook, | 38 | - | - | 37 |
| Framingham Reservoirs Nos. 1 and 2 and Cold Spring Brook. | - | 3 | 3 | - |
| Eastern Sudbury, | - | 3 | 3 | - |
| Indian Brook, | - | - | 1 | - |
| Western Sudbury, | - | - | 2 | - |
| Whitehall Reservoir, | - | 2 | - | - |
| Cedar Swamp, | 97 | - | - | 90 |
| *Cochituate Watershed.* | | | | |
| Snake Brook, | - | - | 2 | - |
| Pegan Brook, | 17 | 1 | 3 | 16 |
| Course Brook, | - | - | - | - |
| Beaver Dam Brook, | 10 | - | 9 | 8 |
| Dug Pond, | 24 | - | 1 | 21 |
| Totals, | 192 | 10 | 27 | 176 |

[1] Including buildings burned, torn down or removed.

## DRAINAGE OF SWAMPS.

The drainage ditches in swamps on the Wachusett and Sudbury watersheds, aggregating 27.5 miles in length, not including those built during the past year, have been cleaned, and the grass, weeds and brush on either side of the ditches for widths varying from 10 to 20 feet mowed and burned. About 26,000 linear feet of the ditches draining into the Sudbury Reservoir were repaired by relaying the paving or by driving the stones back into place with a heavy rammer. The places repaired were generally in pastures, where the side slopes of the ditches and the paving had been damaged by the tramping of the cattle. A 48-inch woven wire fence, 663 feet long, has been built on the property line between the G. H. Buck land and land now or formerly belonging to Marshall Richards and John Dolan, for the purpose of preventing cattle from getting into the bog which surrounds Brigham's Pond.

## Distributing Reservoirs.

The distributing reservoirs maintained by the Board are the Weston and Chestnut Hill reservoirs; the Waban Hill and Forbes Hill reservoirs and the Forbes Hill standpipe of the southern high-service system; Spot Pond and the Mystic Reservoir, near Tufts College, of the northern low-service system; the Fells and Bear Hill reservoirs of the northern high-service system; and the Arlington standpipe of the northern extra high-service system.

### *Weston Reservoir.*

Several beds of shrubbery have been planted in the vicinity of the screen-chamber and the attendant's residence. Considerable labor has been expended in protecting the grounds from the gypsy and brown-tail moths, both by destroying the eggs, nests and caterpillars and by cutting and burning underbrush and thinning out trees, so as to make the work of destroying the moths easier in the future. The reservoir, grounds and buildings are in good condition.

### *Chestnut Hill Reservoir.*

The gate-houses and grounds have received the usual care. The reconstruction of the gravel walk around the reservoir, which was begun a few years ago, has been continued as opportunity offered, and 3,627 feet have been rebuilt during the year. On account of the raising of the grade of Beacon Street by the city of Boston, it became necessary to resurface a portion of the driveway between the two basins of the reservoir, also to trim the lower branches of the trees on the northerly side of the street for a distance of about 1,500 feet. Considerable time was expended in destroying gypsy and brown-tail moths. Sixteen screens have been made for the effluent gate-house No. 2, using wire from the old screens, with new frames and baskets.

### *Waban Hill Reservoir.*

Three beds of shrubbery were set out on the grounds in the spring. The grounds have received the usual care, and both reservoir and grounds are now in good condition.

### *Forbes Hill Reservoir and Standpipe.*

Several beds of shrubbery were set out on the grounds early in the spring. The joints in the masonry of the stone steps leading to the reservoir embankment have been repointed. The reservoir and grounds have been kept in order, and the iron and wood work of the gate-chamber and standpipe tower have been kept painted by the attendant.

### *Spot Pond.*

The reservoir and grounds are in good condition, but a large amount of work is constantly required to protect the trees from being destroyed by the gypsy and brown-tail moths. This work is described in detail in another part of this report. The growth of small birch trees and underbrush on about 50 acres of land in Bear Hill swamp, north of the reservoir, has been thinned out; the brook draining the meadow north of Doleful Pond has been deepened and straightened for a distance of 1,457 feet, and a concrete floor has been laid in the stable.

### *Mystic Reservoir.*

Both the reservoir and grounds are in good condition. The reservoir was shut off from the distribution system from March 19 to April 28, on account of the objectionable taste and odor of the water caused by a growth of Uroglena.

### *Fells and Bear Hill Reservoirs.*

The east basin of the Fells Reservoir was cleaned between April 9 and 21, and the west basin between April 27 and May 2. The total cost of cleaning the reservoir was $579.55. Both the Fells and Bear Hill reservoirs are in good condition with the exception of the woodwork of the gate-houses, which requires painting. Arrangements for doing this work have been made.

### *Arlington Standpipe.*

Early in April the standpipe was emptied for examination, and a considerable quantity of silt and ice removed. During May it was again emptied, thoroughly cleaned and painted. The interior of the standpipe was given one coat of red lead and linseed oil paint,

and two coats of Gilsonite paint obtained from the Barber Asphalt Company. The under side of the roof and the roof trusses were given two coats of red lead, and the exterior of the standpipe and roof were given one coat of white lead and oil paint. The work was done by F. A. Tibbetts of Malden, at a cost of $425.

### *Mystic Lake.*

The railing of the wooden bridge over the dam and 840 feet of fence on the line of Mystic Street have been painted. The gypsy and brown-tail moths on the trees have been destroyed. The house on the grounds near the dam is now unoccupied, the attendant having resigned and moved away on December 15. Arrangements have been made with the Metropolitan Park Commission to have the elevation of the water in the lake taken and reported daily to this department by one of the park policemen.

## Pipe Lines.

Twenty-four leaks have been repaired on the pipe lines, at a cost of $1,685.64. In three cases the pipes broke, in one case the leaded joint between two castings was opened by the movement of a 48-inch curve, and in nineteen cases the leaks were due to defective leaded joints. The first break occurred on February 11, in a 6-inch pipe supplying water to the low-service station at Chestnut Hill. On April 18 a 48-inch curve on the force main leading from the 30,000,000-gallon engine at the Chestnut Hill high-service station split for its entire length, and as a result the basement of the building was flooded with water to a depth of several feet, and the grounds in the vicinity of the building considerably damaged by the water flowing from the pipe. On November 1 a curve in the 48-inch main on Washington Street, Melrose, was broken by the Melrose sewer department while blasting for a sewer trench. There was no water pressure on the pipe at the time of the break, the valves having been closed earlier in the day, at the request of the Melrose authorities. The cost of repairing this break was paid by the city of Melrose. Seven of the defective joints were found on the 36-inch pipes crossing the Charles and Mystic rivers.

Minor changes have been made at several points on the pipe lines, as follows: —

In order to facilitate the construction of the new conduit of the Cambridge Water Works at the junction of Irving and Arsenal

streets in Watertown, the 20-inch main which supplies Watertown and Belmont has been lowered 2.33 feet. The 24-inch pipe near Tufts Square in Medford has been raised 15 inches, to permit of the construction of a surface water drain by the city of Medford. The old 24-inch pipe line crossing Chelsea Creek between Chelsea and East Boston has been straightened at a point near the Chelsea shore, where it is supported upon a pile foundation, and new pile caps have been placed under the pipe. A valve has been set on this line on the East Boston side of the channel, in order to facilitate the control of the flow through the Venturi meter used in measuring the East Boston supply; and brick chambers have been built around two 20-inch valves at the same point, in place of wooden boxes used heretofore.

The pipe bridges over the Saugus and Pines rivers have been cleaned and painted.

Five additional insulating joints have been set in 48-inch pipe lines at different points, for the purpose of reducing the quantity of electric current flowing on the pipes. The location of these joints and the cost of their installation are as follows: —

| Location. | Cost. |
|---|---|
| Boylston and Mount Auburn streets, Cambridge, . . . . . | $234 81 |
| Massachusetts Avenue and Cambridge Street, Cambridge, . . | 194 98 |
| Franklin and North Harvard streets, Brighton, . . . . . | 156 34 |
| Magazine Street, near Central Square, Cambridge, . . . . | 212 00 |
| Norfolk Street, near Broadway, Cambridge, . . . . . . | 157 88 |

The insulation of these joints is accomplished by the substitution of wooden staves for lead in the ordinary bell and spigot joints, with a ring of wood separating the spigot end of one pipe from the socket of the pipe to which it is joined. A wooden joint has also been substituted for the rubber joint in the 48-inch pipe on Massachusetts Avenue, near the crossing of the Fitchburg Railroad, in Cambridge; and a wooden insulating joint placed in the 16-inch connection between the Metropolitan and Boston Water Works mains at the corner of Morton Street and Blue Hill Avenue in West Roxbury.

### Metered Connections.

For measuring the water supplied to the several cities and towns there are now used 55 Venturi meters and 4 Hersey meters of the disc type.

Changes and additions have been made during the year as follows: —

A 20-inch meter with a throat 5.75 inches in diameter has been set on Broadway, near Williams Street, in Chelsea, for use at times when the flow exceeds the registering capacity of the 10-inch meter. The throat of the 12-inch meter at the Revere Reservoir has been enlarged from 3.75 inches to 5 inches in diameter, and an 8-inch throat has been substituted for the 5.25-inch throat on the meter at the corner of Blue Hill Avenue and Morton Street in West Roxbury. All of these changes were made necessary by increase in the consumption of water in the district supplied. In order to measure the quantity of water used by a few takers in Medford, a 1½-inch Hersey disc meter has been set on a by-pass around an 8-inch weighted check valve.

### Pressure Regulators and Recording Gages.

Four pressure regulating valves have been continually in use during the year, for reducing and regulating the water pressure in the pipes in Lexington, Winthrop, Swampscott and Nahant; also two valves operated by floats, for controlling the level of the water in the Revere and Chelsea reservoirs.

No changes have been made in the number of recording gages during the year. The average maximum and minimum elevation of the water, due to the pressure at seventeen points in different parts of the District, as recorded by these gages, are given in Appendix No. 2, Table No. 38.

### Electrolysis.

There has been no great improvement in the electrical conditions on the pipe lines during the past year, and in several districts the pipes continue to be seriously damaged. At the suggestion of the officials of the Boston Elevated Railway Company, additional insulating joints have been set on the two 48-inch pipe lines between the Chestnut Hill pumping station and Spot Pond. Three of these

joints were placed in the westerly line: one in Boylston Street, near Mount Auburn Street, in Cambridge, set on May 25; one in Cambridge Common, set June 1; and one in Franklin Street, near North Harvard Street, Brighton, set June 4. Two joints were placed in the easterly line in Cambridge: one in Magazine Street, near Central Square, set June 9; and one in Norfolk Street, near Broadway, set June 12.

Measurements made in May, before setting these insulating joints, showed that there was a fall of potential, averaging about 20 volts, on the uninsulated street railway returns in both the north and south portions of the districts traversed by these pipe lines; that there were 85 amperes of current leaving the easterly line and 135 amperes leaving the westerly line under conditions likely to produce damage to the Metropolitan mains by electrolysis. In addition to these quantities, there were being delivered to the pipe systems of other cities from both the Metropolitan lines 100 amperes of current, as follows: Boston, 50 amperes; Somerville, 40 amperes; and Medford, 10 amperes.

Measurements taken in July, after the additional joints had been set, indicated that the current leaving the easterly line had been reduced from 85 amperes to about 65 amperes.

The effect of the additional joints in the westerly line could not be determined, on account of the breaking down of a joint in Massachusetts Avenue, near the crossing of the Fitchburg Railroad. This joint was replaced on August 24 with a joint having wood insulation. Upon examination of the old joint, it was found that the sheet rubber, one-half inch in thickness, which was used as insulating material, had been changed to a hard, cinder-like substance for about one inch around several of the bolts on the lower side of the joint, and that this change had destroyed its value as an insulating material. Chemical examination indicated that the rubber had been subjected to high heat without access to oxygen, and the conclusion arrived at is that lightning caused the damage. The iron casting on the positive side of the joint was pitted both outside and inside the pipe by electrolysis, while the negative side was in perfect condition. The largest pitting, which was on the inside of the pipe, was about 6 inches by 4 inches by ½ an inch in depth. As this damage was caused in one year and eight months, it is very evident that the joints did not prevent electrolysis of the pipes, and that joints

under conditions similar to this one will require renewal at frequent intervals.

There are now seven insulating joints on the westerly line and six on the easterly line. As a result of setting these joints, the current leaving the westerly line to cause electrolysis of the Metropolitan pipes has been reduced from about 155 amperes to 120 amperes, and on the easterly line from 140 amperes to 65 amperes.

Measurements made in December, 1903, showed currents of from 5 to 15 amperes flowing southerly on each of the two 24-inch submerged pipe lines crossing Chelsea Creek between Chelsea and East Boston, a portion of which left the pipe in the channel. In September of the past year it was discovered that currents of from 2 to 30 amperes were flowing northerly from the East Boston shore on each of the pipe lines, and that nearly all of this was leaving them before reaching the Chelsea shore. Examination of the pipes showed that they were badly disintegrated, and at one point a hole was cut clear through the pipe while making the examination, causing a leak which had to be plugged. An investigation showed that the reversal of the direction of the current on these pipes was due to the fact that the East Boston power station was shut down for the summer, and that the cars in East Boston were being operated with current from the Lincoln Wharf power station in Boston. On September 10 and 24 tests were made to determine the source of the current, by shutting off for a period of one minute the current from the Lincoln Wharf power station, from which current was being supplied to all the cars in East Boston. On both trials the current flowing on the Metropolitan pipes was from 8 to 22 amperes while the cars were running, and from 0 to 4 amperes while the current was shut off from the Lincoln Wharf station.

The 42-inch, 24-inch and 20-inch pipes in Broadway, Chelsea, are being seriously injured by currents of electricity which flow from them toward the power station of the Boston & Northern Railway in Chelsea. In May, 1906, about 150 amperes of current were flowing on the Metropolitan 24-inch main in Second Street, Chelsea, of which about 50 amperes flowed off through a connection with the pipes of the city of Chelsea, and the remaining 100 amperes flowed off of the Metropolitan mains in Broadway under conditions likely to injure the pipes. In the city of Lynn the 12-inch pipe in Washington Street, near Nahant Road, was uncovered and examined

at two points in April, and pittings were found in the pipe from 1/8 to 3/8 of an inch in depth. The pipe which was relaid in 1904 was also uncovered and examined at one point on Washington Street at Sagamore, and several pittings were found about 1/4 of an inch in depth. Measurements made during the past year indicate that the amount of current flowing on the Metropolitan pipes in Lynn has increased since the last survey was made. Other points where current is leaving the Metropolitan pipes are: Commonwealth Avenue in Newton, near the power station of the Boston Suburban Street Railway; West Street in Hyde Park; Main Street in Stoneham, and Boston Avenue in Medford.

In order to protect the lead sheaths of the telephone cables from injury by electrolysis, it is the practice of the telephone and railway companies to place a bond between the railway returns and the telephone cable sheaths. The result of this is to increase the difference of potential between the telephone cables and the water pipes, and to cause the damage to the pipes to be greater than it would be without the bonds. Several instances of damage to local service pipes and mains where they cross the telephone cables have already been noticed in Cambridge, Chelsea and Hyde Park.

In considering this question, it must be remembered that the quantities, voltage and direction of the currents, as given in this report, represent approximately the average condition at the time the observations were made; but the actual conditions are very erratic, and during even the short period of observation vary through a large range, at times increasing to as much as twice the average and at other times decreasing to zero, or even reversing in polarity and direction. There is also a large change in conditions from day to day, due to the varying traffic and to changes in the distribution of the load between the various power stations. The conditions during the past year have been disturbed more than usual by the installation of new power stations. A new station located on Broadway, at Alewife Brook, in Somerville, was put into service during May, and another located on Salem Street, in Medford, near the Fellsway West, was put into service about September.

With the advent of cold weather, some of the power stations which had been shut down during the summer were placed in service, and power was also obtained by the Boston Elevated Street Railway from the Hyde Park station of the Old Colony Street Rail-

way Company. Alternating current was obtained from the Edison Electric Illuminating Company, which was converted to direct current at substations, one near the bridge between Boston and Charlestown, and the other at the Forest Hills car house on Washington Street in West Roxbury.

## Gypsy and Brown-tail Moths.

Of the land under the control of the Board, used for the purposes of water supply, amounting to about 9,700 acres, not more than 1,000 acres have as yet been infested by the gypsy and brown-tail moths, and the area where the moths are present in sufficient numbers to seriously injure the foliage does not exceed 500 acres. The gypsy moth has been very prevalent around Spot Pond and Mystic Lake, and has been found in considerable and increasing numbers in the vicinity of the Chestnut Hill and Weston reservoirs, at Lake Cochituate, and along the line of the Sudbury, Cochituate and Weston aqueducts as far west as Framingham. The nests of the brown-tail moths have been found not only where the gypsy moths were present, but also on land around the Sudbury Reservoir in Marlborough, Southborough and Framingham, along the line of the Wachusett Aqueduct, and on the grounds about the Wachusett Dam in Clinton.

During January and February a force of about 25 men was employed on the grounds about Spot Pond in painting the egg clusters of the gypsy moth with a mixture of equal parts of creosote and fuel oil. In March and April the trees were thinned out and underbrush cut on about 50 acres of swamp north of the pond, and the trees on 150 acres were scraped and painted with tanglefoot. The spraying of the foliage with arsenate of lead began on May 19 and was continued until the first week in July, the area covered being about 110 acres. For this work one steam, one gas and two hand spraying machines, together with a force of about 25 men, were used. When all the machines were in operation about 200 pounds of arsenate of lead were used daily.

Adjoining the Water Works land at the south end of Spot Pond, for a distance of 2,500 feet, is land belonging to the city of Medford. This land was badly infested with gypsy moths, but nothing was done toward protecting the property. As a result, the trees were stripped of leaves, and great difficulty was experienced in preventing the caterpillars from entering upon the Water Works land and dev-

astating that also. The most efficient means of preventing this was found to be a line of hemlock boards, 10 inches wide, set on edge along the property line and coated on one side with tanglefoot. Hay, sprinkled with fuel oil, was also used for the same purpose, but proved less efficient. The land around the Fells Reservoir is in the custody and control of the Metropolitan Park Commission; but, as the trees in the vicinity of the reservoir were quite badly infested, with the consent of the superintendent of the Fells Reservation, those on a strip 50 feet wide surrounding the reservoir were painted with tanglefoot, and large numbers of caterpillars were destroyed by our employés. At Mystic Lake and at Chestnut Hill Reservoir the egg clusters were destroyed and the foliage sprayed with arsenate of lead. At the Weston Reservoir the number of trees infested with the gypsy moth was comparatively small, and the foliage was not sprayed. Where the caterpillars were discovered, bands of burlap were placed around the trees and the caterpillars killed. On the lands around the reservoirs in Framingham, Southborough and Marlborough, and in the vicinity of the Wachusett Dam in Clinton, a considerable number of the nests of the brown-tail moth were removed from the trees and destroyed. As a result of the work done during the past two years, the number of gypsy moth egg clusters to be destroyed on the property around Spot Pond is very much less than last year; but at the Chestnut Hill Reservoir and at the Weston Reservoir the number has increased, this increase being due in some measure to the neglect of the owners of adjoining properties.

The total amount expended for the work on all the Water Works lands was about $12,700, of which approximately $10,500 was expended in protecting the lands around Spot Pond.

## Clinton Sewerage.

The Clinton sewage disposal works were in daily operation during the whole year. The quantity of sewage pumped and filtered was 795,000 gallons per day, or 152,000 gallons per day more than during the preceding year, and 51,000 gallons per day more than the average during any year since the plant was put into operation in September, 1899. This increase was due to the heavy rainfall during the months of May, June, July and August, which increased the amount of ground water leaking into the town sewers. During these four months the quantity of sewage treated was 60 per

cent. larger than during the corresponding months of the preceding year.

At the pumping station during the early part of the year new plungers and valves were put into the pump. The outside wood work and the interior iron and wood work of the pumping station building have been painted.

Following are statistics relating to the operation of the pumping station: —

| | |
|---|---|
| Daily average quantity of sewage pumped (gallons), | 795,000 |
| Daily average quantity of coal consumed (pounds), | 1,361 |
| Gallons pumped per pound of coal, | 584 |
| Number of days pumping, | 365 |
| Cost of pumping: — | |
| Labor, | $1,284 69 |
| Fuel, | 1,136 95 |
| Repairs and supplies, | 309 59 |
| Total for station, | $2,731 23 |
| Cost per million gallons pumped, | $9 41 |
| Cost per million gallons raised 1 foot high, | 0 19 |

*Filter-beds.*

The sewage has been applied on the filter-beds in practically the same way as in previous years, except that no distinction has been made between the 19 beds from which all soil had been removed when they were built and the 6 beds from which soil to the depth of 6 inches had been removed in 1904.

The 8 settling basins were used in rotation from January 1 to April 4 and from September 14 to the end of the year. During January, February, March and December the sewage was turned through one of the basins for two weeks, when it was drained off and another basin used. At the other times one basin was used for three days, then immediately drained off and another put into use. From April 5 to September 14, while the use of the settling basins was suspended, one of the regular filter-beds was used for the first 30 minutes of each day as a sludge bed to care for the heavy sewage. After being used about a month in this way it was allowed to dry out and then raked and cleaned. In the mean time, another bed was put into use as a sludge bed. The sludge accumulated in the settling basins, and the so-called sludge bed has been given to the

neighboring farmers, who were only too glad to use it on their farms.

During the warmer part of the year, from March 27 to December 2, the sewage was applied to a bed having an area of one acre for 1½ hours, the amount per application being about 163,000 gallons, and each bed was used about once in 4⅔ days, the average rate being about 34,000 gallons per acre per day.

During the colder parts of the year, when the temperature was below 15 degrees above zero, all the sewage of one day's pumping was applied to one of five beds which had been prepared with furrows 3 feet 6 inches apart, the average amount per application being 491,000 gallons, and each bed was used about once in 7 days, which gives an average of about 71,000 gallons per acre per day. When the temperature was higher than 15 degrees above zero the sewage was applied to the other or flat beds for about 1¾ hours, the amount per application being about 177,000 gallons, and each bed was used about once in 9½ days, which gives an average of about 19,000 gallons per acre per day. In previous years during the winter season when the temperature was above 15 degrees above zero the sewage was applied to the flat beds for about 2½ hours; but this year, owing to the milder weather, it has been possible to keep the beds open with less sewage per application.

The results of chemical analyses of the sewage and effluent are given in the following table:—

[Parts per 100,000.]

| | 1901. | 1902. | 1903. | 1904. | 1905. | January to June, 1906, inclusive. | July to December, 1906, inclusive. | Whole Year 1906. |
|---|---|---|---|---|---|---|---|---|
| Albuminoid ammonia, sewage. | 1.0025 | 1.0517 | .9233 | .7967 | 1.1250 | .9017 | .8100 | .8558 |
| Albuminoid ammonia, effluent. | .0741 | .0891 | .0782 | .0686 | .0787 | .1093 | .0816 | .0955 |
| Per cent removed, . . | 91 | 89 | 92 | 91 | 93 | 88 | 90 | 89 |
| Oxygen consumed, sewage, | 10.73 | 8.85 | 8.65 | 8.57 | 13.11 | 9.87 | 9.82 | 9.84 |
| Oxygen consumed, effluent, | .82 | 1.15 | 1.12 | .99 | 1.126 | 1.44 | 1.23 | 1.34 |
| Per cent. removed, . . | 91 | 84 | 87 | 88 | 91 | 85 | 87 | 86 |
| Free ammonia, sewage, . | 3.4533 | 4.3284 | 3.8292 | 3.97 | 4.7533 | 3.3400 | 3.7900 | 3.5650 |
| Free ammonia, effluent, . | .5792 | .6862 | 1.0185 | .99 | .9588 | .9247 | 1.6200 | 1.2723 |
| Per cent. removed, . . | 83 | 84 | 73 | 75 | 80 | 72 | 57 | 64 |
| Nitrogen as nitrates, effluent. | .9298 | .9815 | .4168 | .4046 | .2665 | .0890 | .2000 | .1445 |

The character of the effluent has not been as good as during previous years, and experiments have been in progress, under the direction of the Chief Engineer of the State Board of Health, for the purpose of determining the best method of improving the efficiency of the beds. In May and June three of the filter-beds which were not underdrained at the time the works were constructed were underdrained with 6-inch vitrified pipe, and a well was placed in each bed, for the purpose of obtaining samples of the ground water. A small filter-bed, having an area of .01 of an acre, was built for the purpose of filtering a portion of the effluent from the filters. In July wooden conveyers, having an aggregate length of 784 feet, were placed on two of the beds, for the purpose of securing a uniform distribution of the sewage. The cost of this experimental work was $1,087.37. The investigations are still in progress.

The cost of maintaining the filter-beds, exclusive of the cost of the experimental work, has been as follows: —

| | |
|---|---|
| Labor, | $1,941 52 |
| Repairs and supplies, | 78 62 |
| Total, | $2,020 14 |
| Cost per million gallons filtered, | $6 96 |

## Engineering.

A very large portion of the time of the engineering force is now devoted to matters pertaining to the maintenance and operation of the works. The more important of these matters are the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping.

Appended to this report are tables of contracts giving the amount of work done and other information, a long series of tables relating to the maintenance of the Metropolitan Water Works, tables showing the length of main pipes and number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1906.

Respectfully submitted,

DEXTER BRACKETT,
*Engineer Sudbury and Distribution Departments.*

BOSTON, January 1, 1907.

# REPORT OF ENGINEER OF SEWERAGE WORKS.

*To the Metropolitan Water and Sewerage Board.*

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1906.

## ORGANIZATION.

The engineering organization during the year has been as follows: —

*Division Engineers:* —

| | |
|---|---|
| FREDERICK D. SMITH, . | *In charge of maintenance and construction, South Metropolitan System, in Quincy and Milton.* |
| FRANK I. CAPEN, . . | *In charge of maintenance and construction, North Metropolitan System.* |
| SETH PETERSON,[1] . . | *In charge of construction of air tunnel, Section 80, South Metropolitan System.* |
| FRANK A. EMERY, . . | *In charge of office, drafting room and records.* |

In addition to the above, there were employed at the end of the year 16 engineering and other assistants.

[1] Part of the year.

# METROPOLITAN SEWERAGE DISTRICTS.

## Areas and Populations.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles, — a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1905. It will be noted that the recent census returns do not fully justify all the published forecasts of earlier reports.

*Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1906.*

| | City or Town. | Area (Square Miles). | | Estimated Population. | |
|---|---|---|---|---|---|
| North Metropolitan District. | Arlington, | 5.20 | | 10,080 | |
| | Belmont, | 4.66 | | 4,490 | |
| | Boston (portions of), | 3.45 | | 94,158 | |
| | Cambridge, | 6.11 | | 99,470 | |
| | Chelsea, | 2.24 | | 38,330 | |
| | Everett, | 3.34 | | 30,810 | |
| | Lexington,[1] | 5.11 | | 3,990 | |
| | Malden, | 5.07 | | 39,430 | |
| | Medford, | 8.35 | | 20,390 | |
| | Melrose, | 3.73 | | 14,750 | |
| | Revere, | 5.86 | | 13,470 | |
| | Somerville, | 3.96 | | 71,740 | |
| | Stoneham, | 5.50 | | 6,430 | |
| | Wakefield, | 7.65 | | 10,630 | |
| | Winchester, | 5.95 | | 8,630 | |
| | Winthrop, | 1.61 | | 7,410 | |
| | Woburn, | 12.71 | | 14,460 | |
| | | | 90.50 | | 488,668 |
| South Metropolitan District. | Boston (portions of), | 20.39 | | 152,390 | |
| | Brookline, | 6.81 | | 24,610 | |
| | Dedham,[1] | 9.40 | | 7,630 | |
| | Hyde Park, | 4.57 | | 14,850 | |
| | Milton, | 12.59 | | 7,220 | |
| | Newton, | 16.88 | | 37,940 | |
| | Quincy, | 12.56 | | 28,850 | |
| | Waltham, | 13.63 | | 27,150 | |
| | Watertown, | 4.04 | | 11,740 | |
| | | | 100.87 | | 312,380 |
| | Totals, | | 191.37 | | 801,048 |

[1] Part of town.

# METROPOLITAN SEWERS.

## Sewers Purchased and Constructed and their Connections.

Within the Sewerage Districts there are now 96.74 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 88 miles of Metropolitan sewers having been constructed by the Metropolitan boards.

The position, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

*North Metropolitan System.*

| City or Town. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1906. | Special Connections. Character or Location of Connection. | Special Connections. Number in Operation. |
|---|---|---|---|---|---|
| Boston: — | | | | | |
| Deer Island, | 6' 3" to 9', | 1.367 | 4 | - - | - |
| East Boston, | 9' to 1', | 5.467 | 22 | Shoe factory, | 1 |
| Charlestown, | 6' 7"×7' 5" to 1', | 3.292 | 13 | Navy Yard, | 3 |
| | | | | Almshouse, | 1 |
| Winthrop, | 9', | 2.864 | 7 | Club house, | 1 |
| | | | | Fire Dept. Station, | 1 |
| Chelsea, | 8' 4"×9' 2" to 1' 10"×2' 4", | 5.123 | 9 | Bakery, | 1 |
| | | | | Rendering works, | 1 |
| | | | | Metropolitan Water Works blow-off, | 1 |
| Everett, | 8' 2"×8' 10" to 4' 8"×5' 1", | 2.925 | 6 | Metropolitan Water Works blow-off, | 1 |
| | | | | Cameron Appliance Co., | 1 |
| Malden, | 4' 6"×4' 10" to 1' 3", | 4.493[1] | 26 | Metropolitan Water Works blow-off, | 1 |
| | | | | Private buildings, | 129 |
| Melrose, | 4' 6"×4' 10" to 10", | 6.099[2] | 32 | Private buildings, | 107 |
| | | | | Factory, | 1 |
| | | | | Railroad station, | 1 |
| Cambridge, | 5' 2"×5' 9" to 1' 3", | 7.167 | 29 | Slaughter-house, | 1 |
| | | | | City Hospital, | 1 |
| Somerville, | 6' 5"×7' 2" to 1' 10"×2' 3", | 3.471 | 10 | Tannery, | 1 |
| | | | | Slaughter-houses (3), | 1 |
| | | | | Car-house, | 1 |
| | | | | Stable, | 1 |
| | | | | Rendering works, | 1 |
| Medford, | 4' 8"×5' 1" to 10", | 5.359 | 20 | Armory building, | 1 |
| | | | | Private buildings, | 6 |
| | | | | Stable, | 1 |
| Winchester, | 2' 11"×3' 3" to 1' 3", | 6.428 | 18 | Tannery, | 2 |
| | | | | Private buildings, | 2 |
| | | | | Gelatine factory, | 1 |
| | | | | Stable, | 1 |
| | | | | Railroad station, | 1 |
| Stoneham, | 1' 3" to 10", | 0.010 | 4 | - - | - |
| Woburn, | 1' 10"×2' 4" to 1' 3", | 0.933 | 3 | Glue factory, | 1 |
| Arlington, | 1' 6" to 10", | 3.520[3] | 33 | Private buildings, | 109 |
| | | | | Railroad station, | 1 |
| | | | | Car-house, | 3 |

[1] Includes .988 of a mile of sewer purchased from the city of Malden.
[2] Includes .736 of a mile of sewer purchased from the town of Melrose.
[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

*North Metropolitan System* — Concluded.

| City or Town. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1906. | Special Connections. — Character or Location of Connection. | Special Connections. — Number in Operation. |
|---|---|---|---|---|---|
| Belmont, | – | – | 3 | – | – |
| Wakefield,[1] | – | – | 1 | – | – |
| Revere, | 4' to 3', | 0.048 | 2 | – | – |
| | | 58.566[2] | 237 | | 333 |

*South Metropolitan System.*

| City or Town. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1906. | Special Connections. — Character or Location of Connection. | Special Connections. — Number in Operation. |
|---|---|---|---|---|---|
| Boston (Back Bay), | 6' 6" to 3' 9", | 1.500[3] | 8 | Private house, | 1 |
| | | | | Administration building, Boston Park Department, | 1 |
| | | | | Simmons College buildings, | 1 |
| Boston (Brighton), | 5' 6" to 12", | 3.714[4] | 11 | Abattoir, | 3 |
| Boston (Dorchester). | 3'×4' to 2' 6"×2' 7", | 2.870[5] | 8 | Chocolate works, | 2 |
| | | | | Paper mill, | 1 |
| | | | | Private buildings, | 2 |
| Boston (Roxbury), | 6' 6"×7', 4' 0", | 1.430 | – | – | – |
| Boston (West Roxbury). | 9' 3"×10' 2" to 12", | 7.068 | 9 | Parental school, | 1 |
| | | | | Lutheran Evangelical Church, | 1 |
| | | | | Private buildings, | 4 |
| Brookline, | 5' 6", | 0.127 | 2 | – | – |
| Dedham, | 4'×4' 1" to 3' 9"×3' 10", | 2.350 | 5 | – | – |
| Hull, | 60" pipe, | 0.750 | – | – | – |
| Hyde Park, | 10' 7"×11' 7" to 4'×4' 1", | 4.527 | 14 | Mattapan Paper Mills, | 1 |
| | | | | Private buildings, | 2 |
| Milton, | 11'×12' to 8", | 3.600 | 9 | – | – |
| Newton, | 4' 2"×4' 9" to 1' 3", | 2.911 | 6 | Private houses, | 2 |
| Quincy, | 11' 3"×12' 6" to 24" pipe, | 6.580 | 4 | – | – |
| Waltham, | 3' 6"×4', | 0.001 | 1 | – | – |
| Watertown, | 4' 2"×4' 9" to 12", | 0.750[6] | 5 | Factories, | 2 |
| | | 38.178 | 82 | | 24 |

[1] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.
[2] Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.
[3] Includes .355 of a mile of sewer purchased from the city of Boston.
[4] Includes .026 of a mile of sewer purchased from the town of Watertown.
[5] Includes 1.24 miles of sewer purchased from the city of Boston.
[6] Includes .025 of a mile of sewer purchased from the town of Watertown.

## Cost of Construction.

[To December 31, 1906.]

The cost of the 96.7 miles of Metropolitan sewers enumerated above, including seven stations, siphons and appertaining structures, may be summarized as follows: —

| | |
|---|---|
| North Metropolitan System, | $6,136,200 30 |
| South Metropolitan System, | 7,722,773 15 |
| | $13,858,973 45 |

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

*North Metropolitan District.*

| Area (Square Miles). | Estimated Total Population. | Miles of Local Sewer connected. | Estimated Population contributing Sewage. | Ratio of Contributing Population to Total Population (Per Cent.). | Connections made with Metropolitan Sewers. | |
|---|---|---|---|---|---|---|
| | | | | | Public. | Special. |
| 90.50 | 488,663 | 593.88 | 386,343 | 79.1 | 237 | 383 |

*South Metropolitan District.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 100.87 | 312,380 | 468.18 | 167,070 | 53.5 | 82 | 24 |

*Entire Metropolitan District.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 191.37 | 801,043 | 1,062.06 | 553,413 | 69.1 | 319 | 407 |

Of the estimated gross population of 801,043 on December 31, 1906, 553,413, representing 69.1 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,062.06 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 319 public and 407 special connections. It appears, also, that there has been during the year an increase of 48.75 miles of local sewers connected with the Metropolitan System, and that 9 public and 34 special connections have been added.

## Pumping Stations and Pumpage.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year: —

CONSTRUCTION OF SEWER BY USE OF EXCAVATING MACHINERY IN STREET IN MALDEN FOR EXTENSION OF NORTH METROPOLITAN SEWER.

| Pumping Station. | Average Daily Pumpage. | | | |
|---|---|---|---|---|
| | Jan. 1, 1905, to Dec. 31, 1905. | Jan. 1, 1906, to Dec. 31, 1906. | Increase during the Year. | |
| | Gallons. | Gallons. | Gallons. | Per Cent. |
| Deer Island, | 54,400,000 | 58,100,000 | 3,700,000 | 6.8 |
| East Boston, | 52,400,000 | 56,100,000 | 3,700,000 | 7.1 |
| Charlestown, | 29,900,000 | 30,500,000 | 600,000 | 2.0 |
| Alewife Brook, | 3,234,000 | 3,451,000 | 217,000 | 6.7 |
| Quincy, | 3,180,000 | 3,528,000 | 348,000 | 10.9 |
| Ward Street, | 20,940,000 | 24,500,000 | 3,560,000 | 17.0 |

## CONSTRUCTION.

### NORTH METROPOLITAN SYSTEM.

### Extension of the Metropolitan Sewer in the City of Malden.

Chapter 319 of the legislative Acts of 1906 authorized the extension of a Metropolitan Sewer in Malden from near Barrett's Pond to the tidal meadows on the southerly side of the city.

In 1900, when the town of Wakefield was added to the District, a new Metropolitan sewer was constructed from Wakefield to Barrett's Pond in Malden, and there connected with an existing Metropolitan Sewer.

The original Metropolitan Sewer below this point is now too small to provide for sewage from both sewers. It has, therefore, been found necessary to extend the sewer authorized in 1900 to a point where it can connect with a larger Metropolitan main with overflow into the tidal waters of Malden River, which may serve until the works are more comprehensively relieved.

This extension has been known as Section 64 of the North Metropolitan System.

### *Section 64, Malden Extension.*

*Division Engineer in Charge.*— Frank I. Capen.
*Contractors.*— T. H. Gill & Co., Somerville, Mass.

The section involves a sewer extending from a point on Jackson Street near the crossing of the Saugus Branch of the Boston & Maine Railroad and near Station 55 of Section 40 of the North Metropolitan System, northerly through Jackson Street to Spot Pond

Brook, through private lands, Pleasant Street and Linden Avenue, to a point in Section 58 of the North Metropolitan System 200 feet south of Mountain Avenue, — a total distance of 2,950.5 feet.

Additional data in relation to this route are given in the following table: —

*Extension of the Metropolitan Sewer in Malden, authorized by Chapter 319, Acts of 1906.*

| Location. | Size. | Length (Feet). | Remarks. |
|---|---|---|---|
| Jackson Street from Saugus Branch Railroad to Spot Pond Brook. | 4′ 6″, . | 1,336.98 | Excavation for 330 feet of peat and silt; remainder through miscellaneous filling, with a small layer of sand and gravel over fine sand. |
| Extension of Jackson Street of 205 feet in private land and 582 feet in Linden Avenue at end of section. | 3′ 6″, . | 786.98 | 205 feet excavation in sand and gravel over fine sand; 582 feet in Linden Avenue, coarse sand and gravel with about 3 feet of hardpan at bottom for last 300 feet with boulders. |
| In private land from a point about 200 feet beyond Spot Pond Brook to Pleasant Street at Linden Avenue and in Linden Avenue for about 500 feet. | 2′4″×3′ 6″, | 826.59 | Through the private land the excavation was in sand with some miscellaneous filling above; in Linden Avenue excavation was in coarse sand and gravel. |

A contract was entered into August 8, 1906, with T. H. Gill & Co., of Somerville, contractors, for this construction. The contract extended from Station 0 + 3.80 to 29 + 54.3, — a total distance of 2,950.5 feet.

The contractors started work on Jackson Street at Charles Street on August 14, 1906, and worked in both directions, using a bucket excavator, northerly to a point 200 feet beyond Spot Pond Brook. Southerly toward the Saugus Branch Railroad the work was started with a portable derrick, but this was soon abandoned, and most of the excavation was done without the aid of machinery. Excavation on this portion of the work was completed late in December.

A second opening was started August 15, in private land north of Spot Pond Brook, and worked for part of the distance with a portable derrick. Generally around curves and between buildings the excavation was made without machinery. This portion of the work was completed about the middle of December.

A third opening was started about September 11, at the corner of Linden Avenue and Pleasant Street. A bucket excavator was used

on this part of the work to the end of the section, for a distance of about 950 feet. This excavation was completed December 24.

At the crossing of Spot Pond Brook the route of the brook was temporarily changed through diversion trenches, while 56 feet of trench was excavated, and four lengths of 42-inch cast-iron pipe placed under the brook location. The work was begun September 13 and was completed November 14.

This whole length of sewer was built of standard concrete, except the overflow at Saugus Branch Brook and manholes on the main line of sewer; these were of brick, reinforced with concrete. For a length of 255 feet on the marsh near the Saugus Branch Brook the concrete of the sewer invert rests on piles. For this length the concrete was reinforced with Ransome steel rods longitudinally and transversely in the invert and transversely in the arch.

At the date of the report the work is practically completed except for minor repairs to surfaces in private lands and resurfacing of streets, which, on account of their frozen condition, will be delayed until spring.

The connection with Section 40 by means of a bellmouth at the lower end of this section was made by day labor of the maintenance force of the North Metropolitan Sewerage Works.

## SOUTH METROPOLITAN SYSTEM.

### Extension of the High-level Sewer through West Roxbury, Brookline and Brighton.

Chapter 406 of the legislative Acts of 1906 authorized the construction and operation of an extension of the main sewer of the South Metropolitan System, known as the High-level Sewer, through the districts of West Roxbury, Brookline and Brighton.

During the past year surveys and studies of the geology over the route of the sewer have been in progress. As adopted, the route extends from the corner of Perkins and Centre streets, in Jamaica Plain, through Brookline to Oak Square in Brighton. An outline of this route and other data in relation to it are given in the following table: —

*Extension of the High-level Sewer, authorized by Chapter 406, Acts of 1906.*

| Location. | Size (Diameter). | Length (Feet). | Remarks. |
|---|---|---|---|
| West Roxbury: in Perkins and Chestnut streets, from Centre Street to the boundary line between West Roxbury and Brookline. | 6′ 6″×7′ 0″<br>70″ | 3,085 | 600 feet in rock tunnel.<br>2,485 feet in air tunnel. |
| Brookline: in Chestnut, Kendall and Cypress streets, Brington Road, private land, Gorham Avenue, Greenough, Washington, Park and Winchester streets, private land and Columbia Street to the Brighton boundary line. | 7′ 0″<br>6′ 6″×7′ 0″<br>6′ 3″×6′ 6″<br>5′ 9″×6′ 0″ | 11,760 | 3,360 feet in air tunnel.<br>1,500 feet in rock tunnel.<br>800 feet in earth tunnel.<br>6,100 feet in earth open cut. |
| Brighton: in Harlan Street, private land, Commonwealth Avenue, Warren, Cambridge and Washington streets to Oak Square. | 5′ 9″×6′ 0″<br>60″ cast-iron pipe. | 9,906 | 6,050 feet in rock tunnel.<br>300 feet in earth tunnel.<br>3,556 feet in earth open cut. |
| Branch lines in Cambridge, Market, Bennett and Washington streets. | 24″×28″ to 12″ | 5,050 | 2,250 feet in tunnel.<br>2,800 feet in earth open cut. |
| | | 29,800 | |
| | | 5.64 miles. | |

For convenience, this length of 5.64 miles has been divided into contract sections, numbered from 80 to 86, both inclusive.

## *Section 80, West Roxbury and Brookline.*

*Division Engineer in Charge.*—SETH PETERSON.
*Superintendent of Construction by Day Labor.*—CHARLES A. HASKIN.

This section extends from a branch in the existing bellmouth at the corner of Centre and Day streets along Perkins and Chestnut streets, in West Roxbury, passing Jamaica Pond, to the Brookline town line; thence in Brookline, along Chestnut Street to near Kendall Street, a length of about 4,500 feet. It is wholly in tunnel, at depths ranging from 70 feet in Perkins Street to about 20 feet in Chestnut Street. From Centre Street to near Zamora Street and along Perkins Street it is anticipated the tunnel headings will be in Roxbury puddingstone, with seams of clay and quicksand that may admit water freely to the headings.

From Zamora Street, passing Jamaica Pond, to near the end of the section, the tunnel headings are expected to be in open sand and quicksand. The water line of the sewer passing Jamaica Pond is about 35 feet below the usual elevation of the water surface of the pond. To avoid any possibility of accident to Jamaica Pond, the tunnel work in its vicinity is being carried out by pneumatic proc-

HEADING IN SEWER TUNNEL IN WEST ROXBURY BUILT IN QUICKSAND BY PNEUMATIC PROCESS.

esses and by day labor, under the direction of Charles A. Haskin, pneumatic expert.

A shaft leading down to the tunnel is located on Perkins Street, about 475 feet east of Jamaicaway. At this point an unoccupied lot, about 65 feet by 150 feet, has been rented, and lockers for machinery, tools and supplies erected.

Work on the shaft was begun October 3, 1906. The shaft is circular, 8 feet inside diameter, with 12-inch Portland brick walls. Steel cylinders 20 feet long were first sunk in the street, and lined with 12-inch Portland brickwork; excavation then proceeded in depths of 3 feet, secured by polings. The masonry below the steel casing was suspended by rods from the casing itself.

This method of shaft excavation was pursued for a depth of 57 feet below the surface. At that depth water was encountered. An air lock was then introduced on the head of the steel cylinders at the street, and an air pressure about 6 pounds in excess of atmospheric pressure maintained. The completed shaft is 70 feet in depth. At the date of this report tunnel headings have advanced about 70 feet each way from the shaft. The vertical air lock was removed December 24, and horizontal locks have been constructed in each heading. The west heading is now in fine, sharp sand, and advancing at the rate of about 30 feet per week under 6 pounds of air pressure. The east heading is in sand, gravel and quicksand, and advancing at the rate of about 40 feet per week under air pressure of about 6 pounds per square inch.

The plant for carrying out this work includes 2 horizontal tubular boilers of 100 horse-power each, and 1 of 75 horse-power; 3 air compressors of Rand type, 75 horse-power each; hoisting engine at the shaft, and two electric generating sets of 100 16-candle-power lights each.

The completed tunnel is circular, in cross-section, 7 feet inside diameter, with 12-inch Portland brick walls. Steel tunnel plates are used to cover the arch for about one-half its periphery.

### Reversal of Grade at the Lower End of the Charles River Main Sewer.

At the date of the last report about 1,100 feet of the invert of the Charles River main sewer east from Vancouver Street had been modified by introducing a concrete invert about 3 feet in diameter,

having an inclination of 1 foot in 1,500 feet in the direction of the main sewer leading to the Ward Street station.

On March 19, 1,860 feet of the modified invert had been completed, to Bryant Street. This length provides for all Metropolitan connections on this branch, and the sewage from these Metropolitan areas was deflected from the city of Boston works to the South Metropolitan System on the following dates: —

| | |
|---|---|
| Parker Street district, 15-inch connection, . . . . | January 15, 1906. |
| Hemenway Street district, 12-inch connection, . . . | February 14, 1906. |
| Bryant Street district, 12-inch connection, . . . . | February 14, 1906. |
| Bryant Street district, 24-inch connection, . . . . | March 19, 1906. |

Below the Bryant Street connection a 40-inch penstock valve has been introduced at the end of the modified invert.

From Bryant Street to Gainsborough Street the Charles River main sewer, 6 feet 6 inches in diameter, was cleared of deposit, washed, and the exclusion valve at Gainsborough Street closed.

Between the valves at Bryant and Gainsborough Streets is a length of about 1,600 feet of abandoned sewer, now filled with ground water.

From the commissioner's channel of Stony Brook to Bryant Street, for a length of 561 feet, a reinforced concrete drain, equivalent in size to a 36-inch pipe, was constructed below the modified invert. This connects with a 35-inch branch from Stony Brook, which has sometimes been used by the city for flushing the Huntington Avenue sewer with water from Stony Brook. The arch of this drain was reinforced with expanded metal of sufficient strength to resist any pressure that might reach it.

### Section 77, Ward Street Station and Connections.

At the date of the last report the pumping plant at the Ward Street station had not been formally tested or accepted. During the past year the tests prescribed in contracts with the engine builders have been successfully carried out, and the plant formally accepted by the Board.

This plant was installed for raising sewage from the Charles River valley Metropolitan Sewerage District, about 40 feet to the High-level Sewer, recently constructed. Through this sewer it is discharged into the waters of Boston harbor, off Nut Island, in Quincy.

The engines, pumps and steam plant were furnished by the Allis-Chalmers Company of Milwaukee, Wis., under a contract dated January 17, 1902. The pumps are specially designed for pumping sewage.

The sewage is delivered to the station through a trunk sewer in Vancouver Street 7 feet 9 inches by 6 feet 6 inches. Before entering the station, sewage is passed through screens which intercept rags, paper and other floating materials.

The screens are of 3/4-inch round iron bars, securely held in steel frames. These frames, with intercepted material, are mechanically raised to the level of the screen-chamber floor.

After passing the screens, sewage is delivered through concrete and cast-iron pipes to the pumps. Beyond the pumps, sewage is forced through lines of 48-inch cast-iron pipes, about 1,600 feet in length, to the High-level Sewer, which conveys it by gravity to an outlet in the harbor.

The pumps were first operated in September, 1904. By agreement between the Board and the Allis-Chalmers Company, they have been operated in the regular service of the station since October 14, 1904, prior to official test and acceptance by the Board. The official trials, specified in the contract, were made November 9 and December 4, 1906; on December 12, 1906, the whole plant was formally accepted by the Board.

The tests were conducted by F. I. Capen and F. A. Emery, Division Engineers, and William M. Francis, Engineer in charge of the station, for the Metropolitan Sewerage Works, and T. T. Hubbard, M.E., representing the Allis-Chalmers Company.

*Description of Plant.*

The contract with the Allis-Chalmers Company was for furnishing and erecting two engines, each of 50,000,000 gallons daily capacity, together with four vertical, tubular boilers of the Deane type, with piping and other accessories.

The engines are of the vertical triple-expansion direct-connected plunger type, with pump plungers directly under the steam cylinders. The pumps up to and including the engine crank shafts were built at the "Reliance Works," and the steam ends, including the massive "A" frames and upper bed-plates, at the West-Allis Works, Milwaukee. The final fitting and assembling of these parts occurred at the Ward Street station.

The steam ends of the pumps are practically standard design, the several cylinders being, respectively, 21 inches, 38 inches and 58 inches in diameter, with a total plunger movement of 60 inches.

The pump plungers are suspended from the cross heads of the several cylinders by four rods guided at intervals throughout their length. This affords a rigid connection between the piston and the plunger and a direct drive from the one to the other. Each engine has two suction and two discharge pipes lying externally to the suction and discharge chambers with which they are respectively connected.

The discharge pipe on either side of each engine lies immediately above and in the same vertical plane with each suction pipe. The plunger chambers lie in the longitudinal centre line of the engine, and between two suction and two delivery chambers, which are in line diametrically opposite to the longitudinal centre line of the engine.

The castings for the discharge chambers are extended vertically, forming air chambers and at the same time supports for the pillow block bed-plates of the engines. X-braces span the distances between the valve chambers, rendering the construction extremely rigid.

Each engine has three single-acting outside-packed plungers, and six suction and six delivery valve chambers. Each suction and delivery chamber contains 36 valves, making a total of 432 valves for each engine. These valves were specially designed to act with sewage, and are of the flap type, with rubber and canvas seats which are bolted to brass plates. They are hinged, and swing on a manganese bronze hinge bolt.

The nominal area of the waterway through the suction and discharge valves is about 200 per cent. of the area of the pump plungers.

The steam inlet and exhaust valves in the heads of the high and intermediate-pressure cylinders are operated by valve gear of the Reynolds-Corliss type. The steam and exhaust valves in the heads of the low-pressure cylinder are in duplicate, and are of the poppet type, operated by cams. The governor controls the time of cutting off in the high-pressure cylinder, or it may be adjusted and fixed by hand.

The cut-off in the intermediate-pressure cylinder is adjustable by hand, while that on the low-pressure cylinder is fixed and cannot

be altered. All valves receive their motion from eccentrics on a lay shaft which is driven by cranks on either end, set at 90° and connected by driving rods with cranks on the main engine shaft.

The steam cylinders are jacketed on barrels. Reheating coils introduced between the cylinders have been isolated and plugged, and the introduction of steam through the jackets is now as follows: Steam from the high-pressure jackets is led to a Flynn trap, the discharge of which outlets to the low-pressure cylinder jacket. A branch from the inlet pipe of this trap furnishes steam, under a pressure which is regulated by hand, to the jacket of the intermediate cylinder. The outlet from the intermediate jacket is piped to a second Flynn trap, which also discharges into the jacket of the low-pressure cylinder. The drain from the discharge side of the low-pressure cylinder jacket is piped to the feed-water tank.

Surface condensers using sewage as a cooling medium were contemplated by the contract. In place of these, a modification of the Bulkley or barometric type of condenser, adapted to the use of sewage for cooling, was introduced. The passages through this condenser are larger than ordinarily used with clear water. These condensers have been furnished in duplicate with each engine, and so arranged that any one may be in operation while all the others are shut off.

Exhaust steam circulates through a feed-water heater placed in the exhaust pipe before entering the condenser.

The supply of fresh water for boiler feed is first circulated around the jacket of the dry-air pump, then to the feed-water heater in the exhaust pipe from the engine, and thence to the supply tank for the feed pump. Here it mingles with the discharges from the cylinder-jacket drains, from which receptacle it is drafted by a feed pump driven from the main engine, and forced through a fuel economizer before arriving at the boilers. The economizer is of the standard Green type, with 140 tubes, each 4 $9/16$ inches in diameter and 9 feet long, around which the escaping gases from the boilers pass on their way to the chimney.

Steam is furnished by four vertical fire-tube boilers, designed by and built under supervision of Dean & Main, mechanical engineers, for the Allis-Chalmers Company. The steam is supplied to the engine through duplicate lines of 8-inch pipe fitted with Van Stone steam joints and controlled by stop-valves of Chapman make.

The following tables contain principal dimensions of engines and boilers: —

*Principal Dimensions of Engines.*

| | |
|---|---|
| Diameter H. P. cylinder (inches), | 21 |
| Diameter I. P. cylinder (inches), | 38 |
| Diameter L. P. cylinder (inches), | 58 |
| Diameter plungers (inches), | 48.25 |
| Stroke of pistons and plungers (inches), | 60 |
| Diameter of suction pipes (2) (inches), | 42 |
| Diameter of discharge pipe (1) (inches), | 48 |
| Diameter of fly wheels (2), each engine (feet), | 18 |
| Revolutions per minute for capacity, | 25 |
| Piston speed per minute for capacity (feet), | 250 |

*Principal Dimensions of Boilers.*

| | |
|---|---|
| Length of shell, | 24′ 11⅛″ |
| Internal diameter of shell, | 90⅝″ |
| Thickness of shell plates, | ⅝″ |
| Number and diameter of tubes, | 302–2″ |
| Length of tubes, | 14′ 11⅞″ |
| Water heating surface (square feet), | 1,758.55 |
| Super heating surface (square feet), | 627.12 |
| Total heating surface (square feet), | 2,385.67 |
| Grate area (square feet), | 33.18 |
| Area through tubes (square feet), | 5.47 |
| Area through smoke flue nozzle (square feet), | 7.00 |
| Ratio water heating surface to grate area, | 53: 1 |
| Ratio total heating surface to grate area, | 72: 1 |
| Ratio grate area to tube area, | 6.07: 1 |
| Ratio grate area to smoke flue nozzle, | 4.74: 1 |

## *Trials.*

The type and design of boiler were specified to the engine builders, so that no formal boiler tests have been required or made.

The engines are duplicates, — all the moving parts are identical in both engines. The record of their operation for about two years has indicated that they are equally efficient.

To avoid delay and inconvenience in maintaining the continuous service at the station, the Board, on May 21, 1906, agreed to accept tests on one engine as representative of both.

The engine selected for testing has been known as No. 1, and is located at the westerly end of the engine room. A 36-inch cast-iron by-pass pipe leads from the discharge pipe of this engine around the easterly end of the station to the suction sewer. It was thus possi-

ble to circulate the discharge from this pump continuously through the pump and station. A controlling valve in the pipe line provided for throttling the pipe until the pressure specified in the contract test was obtained.

A temporary weir was erected along the line of this by-pass. The weir is 10 feet long, with angle-iron crest. The sewage approaches the weir through stilling racks placed in the channel of approach, which is about 24 feet long. The head of water over the weir has been measured by hook gages located in a measuring chamber at one side of the weir. The water in this chamber is supplied through an orifice in the wall of the weir chamber.

Two boilers furnished steam used during the tests. Steam was conveyed to the engine through one of the duplicate 8-inch steam mains, and, in order that leakage should be reduced to the minimum, all connections between it and auxiliary lines were blanked off by pieces of boiler plate inserted between the flanges of connecting branches.

The feed water was taken directly from the city mains, weighed in barrels resting on platform scales, and fed to the boilers by the feed pump connected with the engine under test through a temporary 2-inch pipe line. Pressure on the 36-inch discharge line from the pump was indicated by a mercury column.

During the test the sewage used as a cooling medium in the barometric condensers was delivered over a weir. This amount was determined and proper correction made for it in estimating the total volume of the sewage pumped.

*Trial Data and Results.*

[Engine tested (represented action of two), No. 1.]

| - | Capacity and Slip Trial. | Duty Trial. |
|---|---|---|
| Date of trial, | Nov. 9, 1906, | Dec. 4, 1906. |
| Duration of trial, | 6 hours, | 10 hours. |
| *Average Pressures.* | | |
| Steam at boilers (pounds), | - | 152.3 |
| Steam at throttle (pounds), | - | 151.13 |
| First receiver (pounds), | - | 30.63 |
| Second receiver (pounds), | - | —2.54 |
| Vacuum (pounds per square inch), | - | 27.9 |

*Trial Data and Results* — Concluded.

[Engine tested (represented action of two), No. 1.]

| | Capacity and Slip Trial. | Duty Trial. |
|---|---|---|
| *Average Temperatures (Degrees F.).* | | |
| Water fed to boiler, | - | 104 |
| Water in force main, | - | 54.35 |
| *Head pumped against.* | | |
| Average net head pumped against (pounds pressure), | 17.5 | 17.6 |
| Average net head pumped against (feet), | 40.3 | 40.5 |
| *Revolutions.* | | |
| Total revolutions during tests, | 8,882 | 14,591 |
| Average revolutions per minute, | 24.67 | 24.32 |
| Average piston speed (feet per minute), | 246.76 | 243.28 |
| *Useful Work performed by Engine.* | | |
| Total water pumped (no allowance for slip), plunger displacement of pumps (United States gallons). | 12,659,000 | 20,796,000 |
| *Water fed to Boilers.* | | |
| Total water fed to boilers (pounds), | - | 47,433 |
| Deduction for leakage, storage and use of calorimeter (pounds), | - | 1,116 |
| Total steam chargeable to engine (pounds), | - | 46,317 |
| *Steam used by Engine.* | | |
| Average entrainment in steam entering engine (per cent.), | - | .696 |
| Total dry steam used by engine (pounds), | - | 45,996 |
| *Duties.* | | |
| Capacity per 1,000 pounds commercially dry steam, plunger displacement (contract basis) (foot-pounds). | - | 152,719,000 |
| *Weir Measurements.* | | |
| Length of weir (feet), | 9.956 | 9.957 |
| Average depth of water on weir (feet), | 1.7145 | 1.6878 |
| Calculated discharge over weir (gallons), | 48,124,000 | 46,989,000 |
| Calculated discharge of condenser water over weir (gallons per 24 hours). | 1,009,000 | 1,110,000 |
| Total calculated discharge from pumps (gallons per 24 hours), | 49,133,000 | 48,099,000 |
| Volume displaced by plungers (gallons per 24 hours), | 50,635,000 | 49,908,000 |
| Slip (per cent.), | 2.97 | 3.62 |

### Concrete Walks and Fences at Ward Street Station Lot.

During the year a granolithic sidewalk has been placed on the Ward Street front of the pumping station lot, together with a granolithic walk, 12 feet wide, from the sidewalk to the main door of the engine room.

A substantial iron fence secured to masonry posts is being placed along the Ward Street side of the lot. Permanent picket fences have been placed along Vancouver Street and the north side of the station lot. The work on the fences and walks has been carried out from time to time by day labor of the maintenance force, as it was found possible to withdraw the labor from regular maintenance work.

### Additional Pumping Plant at Quincy Station.

The ordinary sewage flow at this station exceeds the capacity of the smaller pump now in use, and during wet weather of winter and spring the flow has exceeded for considerable periods the capacity of both pumps now in use.

During the year additional pumping plant has been installed. On August 29 the Board purchased, of the Lawrence Machine Company of Lawrence, Mass., one of their standard design centrifugal pumps. This pump has 16-inch side suction, with 15-inch bottom discharge and 46-inch impellers. The pump is directly connected to a vertical cross-compound Sturtevant engine of the standard type. The steam cylinders are 10 inches and 18 inches in diameter, with 10-inch stroke. This plant has a range of capacity from 4,000,000 to 10,000,000 gallons per 24 hours, with lifts from 17 to 28 feet.

The foundations for the pump and engine were built under the direction of the Engineer by day labor. The suction and discharge piping for the pump was furnished and placed by the Board.

Miscellaneous piping and accessories from the engine to boilers, including feed pump and condenser, are to be furnished by the Board and erected by the engineer in charge of the station and his assistants.

Two additional boilers, of about 100 horse-power each, have also been introduced. These were furnished under contract with the Robb-Mumford Company of South Framingham, dated August 31, 1906. They are of the horizontal return tubular type, with overhanging fronts and masonry settings, similar in general design and

outline to boilers already existing at the station. The foundations for the boilers were built by day labor, under the direction of the Engineer.

General data in relation to these boilers is given in the following table: —

| | |
|---|---|
| Diameter (inches), | 66 |
| Length of tubes (feet), | 16 |
| Outside diameter of tubes (inches), | 3 |
| Number of tubes, | 110 |
| Grate area (square feet), | 30 |
| Nominal horse-power of each boiler, | 96 |
| Working pressure per square inch (pounds), | 125 |
| Hydrostatic test pressure (pounds), | 200 |

At the date of this report the boilers are in place, with smoke flue connected to the chimney. The pump and engine are placed, with suction and discharge piping partly placed. It is anticipated that this new plant will be in condition to operate in the coming spring.

## MAINTENANCE.

### Scope of Work and Force Employed.

The maintenance of the Metropolitan Sewerage System includes the operation of seven stations and 96.74 miles of Metropolitan sewers, receiving the discharge from 1,062.06 miles of town and city sewers at 319 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 134 men includes 81 engineers and other employés at the pumping stations, and 53 men employed on actual sewer maintenance and care of pumping station grounds. In the three following tables the use of the completed systems and other data are shown: —

## North Metropolitan System.

*Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1906.]

| Cities and Towns. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection.[1] | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Square Miles. | Square Miles. | Per Cent. | Per Cent. |
| Boston (Deer Island), | 0.70 | Separate, | - | - | 1,123 [2] | 1,123 [2] | - | - | 100.0 | - |
| Winthrop, | 26.96 | Separate, | 1,822 | 4.0 | 7,290 | 7,410 | 1.23 | 1.61 | 98.4 | 76.4 |
| Boston (East Boston), | 27.19 | Separate and combined, | 4,006 [3] | 12.5 | 50,075 | 52,990 | 0.99 | 2.18 | 94.5 | 45.4 |
| Chelsea, | 9.00 [4] | Separate and combined, | 1,134 | 7.1 | 8,050 | 38,330 | 0.42 | 2.24 | 21.0 | 18.8 |
| Everett, | 41.91 | Separate and combined, | 3,957 | 6.1 | 24,140 | 30,810 | 1.86 | 3.34 | 78.4 | 55.7 |
| Malden, | 49.41 | Separate, | 4,634 | 5.6 | 25,950 | 39,430 | 2.61 | 5.07 | 65.8 | 51.5 |
| Melrose, | 33.36 | Separate, | 2,461 | 4.3 | 10,580 | 14,750 | 1.65 | 3.73 | 71.7 | 44.2 |
| Boston (Charlestown), | 21.08 | Separate and combined, | 5,141 | 7.75 | 39,845 | 40,040 | 0.67 | 1.27 | 99.5 | 52.8 |
| Cambridge, | 133.76 [5] | Separate and combined, | 14,656 | 6.7 | 98,195 | 99,470 | 4.94 | 6.11 | 98.7 | 80.9 |
| Somerville, | 88.67 | Separate and combined, | 13,300 | 5.3 | 70,490 | 71,740 | 3.28 | 3.96 | 98.3 | 82.8 |
| Medford, | 49.20 | Separate, | 3,386 | 5.5 | 18,620 | 20,390 | 2.64 | 3.35 | 91.3 | 81.6 |
| Winchester, | 21.85 | Separate, | 975 | 5.3 | 5,170 | 8,630 | 1.07 | 5.95 | 59.9 | 18.0 |
| Woburn, | 13.00 [6] | Separate, | 942 | 5.4 | 5,085 | 14,460 | 0.91 | 12.71 | 35.2 | 7.2 |
| Stoneham, | 11.27 | Separate, | 585 | 4.3 | 2,515 | 6,430 | 0.60 | 5.50 | 39.1 | 10.9 |
| Arlington, | 19.80 | Separate, | 1,006 | 6.1 | 6,135 | 10,080 | 1.65 | 5.20 | 60.9 | 31.7 |
| Belmont, | 10.05 | Separate, | 324 | 6.0 | 2,870 [7] | 4,490 | 0.93 | 4.66 | 52.8 | 20.0 |
| Wakefield, | 11.20 | Separate, | 389 | 5.5 | 2,140 | 10,630 | 0.42 | 7.65 | 20.1 | 5-5 |
| Lexington,[8] | - | - - | - | - | - | 3,990 | - | 5.11 | - | - |
| Revere, | 25.47 | Separate, | 1,785 | 4.8 | 8,570 | 18,470 | 1.57 | 5.86 | 63.6 | 26.8 |
| Totals, | 593.88 | - - | 60,503 | 6.4 | 386,343 | 488,663 | 27.44 | 90.50 | 79.1 | 30.3 |

[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1906.
[2] Estimated by Superintendent J. R. Gerrish of the Institution on Deer Island.
[3] East Boston house connections recounted from City of Boston Records.
[4] Only the districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue and Willoughby Street are now contributing sewage.
[5] Revised in accordance with recent report of the City Engineer.
[6] Exclusive of Mystic River valley sewer and tanneries.
[7] Including 2 connections with McLean Hospital, having an estimated population of 428.
[8] Lexington not connected.

## South Metropolitan System.

*Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1906.]

| Cities and Towns. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection.[1] | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Square Miles. | Square Miles. | Per Cent. | Per Cent. |
| Boston (Back Bay), | 22.15 | Separate and combined, | 1,519 | 16.0 | 24,305 | 24,460 | 1.20 | 1.61 | 99.4 | 74.5 |
| Boston (Brighton), | 53.53 | Separate and combined, | 2,679 | 6.1 | 16,340 | 23,250 | 3.16 | 3.74 | 70.3 | 84.5 |
| Brookline, | 57.39 | Separate and combined, | 3,152 | 7.5 | 23,640 [2] | 24,610 | 3.24 | 6.81 | 96.1 | 47.6 |
| Newton, | 101.76 | Separate, | 5,202 | 5.8 | 20,170 | 37,940 | 6.81 | 16.88 | 79.5 | 40.3 |
| Watertown, | 32.68 | Separate, | 1,657 | 5.1 | 8,450 | 11,740 | 1.84 | 4.04 | 72.0 | 45.5 |
| Waltham, | 41.56 | Separate, | 2,868 | 8.65 [2] | 24,810 | 27,150 | 2.16 | 13.63 | 91.4 | 15.8 |
| Boston (Dorchester), | 30.55 | Separate and combined, | 2,018 | 6.7 | 13,520 | 44,180 | 1.52 | 4.89 | 30.6 | 31.1 |
| Milton, | 7.48 | Separate and combined, | 195 | 5.2 | 1,015 | 7,220 | 0.39 | 12.59 | 14.0 | 3.1 |
| Hyde Park, | 20.96 | Separate, | 1,010 | 7.9 [2] | 7,980 | 14,850 | 1.10 | 4.57 | 53.7 | 24.1 |
| Dedham, | 14.30 | Separate, | 340 | 5.1 | 1,735 | 7,680 [3] | 0.72 | 9.40 | 22.7 | 7.7 |
| Boston (Roxbury), | - | - - | - | - | - | 32,720 | - | 1.23 | - | - |
| Boston (West Roxbury), | 38.60 | Separate, | 1,963 | 6.75 | 13,750 [4] | 27,780 | 1.93 | 8.92 | 49.5 | 21.6 |
| Quincy, | 47.22 | Separate, | 2,103 | 5.4 | 11,355 | 28,850 | 2.36 | 12.56 | 39.4 | 18.8 |
| Totals, | 468.13 | - - | 24,706 | 6.8 | 167,070 | 312,380 | 26.43 | 100.87 | 53.5 | 26.2 |

[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1906.
[2] Estimated by City Engineer.
[3] Part of town not included in Metropolitan Sewerage District.
[4] Including connection with Institution at Austin Farm having an estimated population of 500.

## WHOLE METROPOLITAN SYSTEM.

*Table showing Areas delivering Sewage to the Entire System, inclusive of Added High-level Area; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1906.]

| SYSTEM. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection. | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Square Miles. | Square Miles. | Per Cent. | Per Cent. |
| North Metropolitan, . | 593.88 | Separate and combined, | 60,503 | 6.4 | 386,343 | 488,663 | 27.44 | 90.50 | 79.1 | 30.3 |
| South Metropolitan, . | 468.18 | Separate and combined, | 24,706 | 6.8 | 167,070 | 312,380 | 26.43 | 100.87 | 53.5 | 26.2 |
| Totals, . . . | 1,062.06 | - - | 85,209 | 6.5 | 553,413 | 801,043 | 53.87 | 191.87 | 69.1 | 28.1 |

## CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan Sewerage stations: —

### North Metropolitan System.

### *Deer Island Pumping Station.*

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

**Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.**
**Average duty for the year: 57,600,000 foot-pounds.**
**Average quantity raised each day: 58,100,000 gallons.**
**Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.**
**Coal used: first-quality Cumberland, costing from $3.44 to $3.95 per ton.**

*Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.*

| Months. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 1,867,600,000 | 60,200,000 | 48,300,000 | 91,500,000 | 10.79 | 62,600,000 |
| February, | 1,744,500,000 | 62,300,000 | 49,400,000 | 84,800,000 | 10.77 | 59,800,000 |
| March, | 2,471,400,000 | 79,700,000 | 63,600,000 | 124,300,000 | 11.01 | 60,200,000 |
| April, | 2,219,200,000 | 74,000,000 | 53,500,000 | 108,800,000 | 11.15 | 55,800,000 |
| May, | 1,803,300,000 | 58,200,000 | 45,400,000 | 111,600,000 | 10.79 | 54,300,000 |
| June, | 1,670,100,000 | 55,700,000 | 48,000,000 | 72,100,000 | 10.68 | 52,600,000 |
| July, | 1,684,400,000 | 54,300,000 | 42,800,000 | 81,900,000 | 10.60 | 59,400,000 |
| August, | 1,459,300,000 | 47,100,000 | 39,800,000 | 58,700,000 | 10.35 | 57,300,000 |
| September, | 1,399,000,000 | 46,600,000 | 41,800,000 | 62,200,000 | 10.15 | 60,700,000 |
| October, | 1,445,600,000 | 46,600,000 | 39,300,000 | 71,200,000 | 10.27 | 54,100,000 |
| November, | 1,576,900,000 | 52,600,000 | 42,300,000 | 89,600,000 | 10.58 | 57,400,000 |
| December, | 1,858,200,000 | 59,900,000 | 45,900,000 | 85,100,000 | 10.73 | 57,300,000 |
| Total, | 21,199,500,000 | - | - | - | - | - |
| Average, | - | 58,100,000 | 46,700,000 | 86,400,000 | 10.66 | 57,600,000 |

### *East Boston Pumping Station.*

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

**Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.**
**Average duty for the year: 56,500,000 foot-pounds.**
**Average quantity raised each day: 56,100,000 gallons.**
**Force employed: 4 engineers, 4 firemen, 4 oilers, 3 screenmen and 1 relief screenman.**
**Coal used: first-quality Cumberland, costing from $3.45 to $4.25 per ton.**

*Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 1,805,600,000 | 58,200,000 | 46,300,000 | 89,500,000 | 16.47 | 61,600,000 |
| February, | 1,688,500,000 | 60,300,000 | 47,400,000 | 82,800,000 | 16.73 | 59,600,000 |
| March, | 2,409,400,000 | 77,700,000 | 61,600,000 | 122,300,000 | 17.43 | 58,500,000 |
| April, | 2,159,200,000 | 72,000,000 | 51,500,000 | 106,800,000 | 17.31 | 58,000,000 |
| May, | 1,741,300,000 | 56,200,000 | 43,400,000 | 109,600,000 | 16.68 | 56,700,000 |
| June, | 1,610,100,000 | 53,700,000 | 46,000,000 | 70,100,000 | 16.53 | 50,200,000 |
| July, | 1,622,400,000 | 52,300,000 | 40,800,000 | 79,900,000 | 16.42 | 56,200,000 |
| August, | 1,397,300,000 | 45,100,000 | 37,800,000 | 51,700,000 | 16.24 | 59,700,000 |
| September, | 1,339,000,000 | 44,600,000 | 39,800,000 | 60,200,000 | 16.20 | 54,800,000 |
| October, | 1,383,600,000 | 44,600,000 | 37,300,000 | 69,200,000 | 16.20 | 56,500,000 |
| November, | 1,516,900,000 | 50,600,000 | 40,300,000 | 87,600,000 | 16.23 | 50,900,000 |
| December, | 1,796,200,000 | 57,900,000 | 43,900,000 | 83,100,000 | 16.60 | 55,700,000 |
| Total, | 20,469,500,000 | - | - | - | - | - |
| Average, | - | 56,100,000 | 44,700,000 | 84,400,000 | 16.59 | 56,500,000 |

## *Charlestown Pumping Station.*

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.
Average duty for the year: 59,300,000 foot-pounds.
Average quantity raised each day: 30,500,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: first quality Cumberland, costing from $3.45 to $3.95 per ton.

*Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.*

| Months. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 939,400,000 | 30,300,000 | 23,800,000 | 47,400,000 | 7.89 | 56,700,000 |
| February, | 923,900,000 | 33,000,000 | 25,800,000 | 41,900,000 | 8.55 | 60,900,000 |
| March, | 1,169,800,000 | 37,700,000 | 28,800,000 | 60,200,000 | 8.79 | 61,700,000 |
| April, | 1,012,500,000 | 33,700,000 | 27,100,000 | 52,100,000 | 8.50 | 63,900,000 |
| May, | 957,600,000 | 30,900,000 | 25,700,000 | 60,300,000 | 8.30 | 62,100,000 |
| June, | 905,800,000 | 30,200,000 | 26,000,000 | 40,900,000 | 8.24 | 62,700,000 |
| July, | 931,600,000 | 30,100,000 | 22,100,000 | 43,500,000 | 8.17 | 64,500,000 |
| August, | 861,700,000 | 27,800,000 | 24,100,000 | 32,700,000 | 8.39 | 61,500,000 |
| September, | 809,400,000 | 27,000,000 | 23,900,000 | 38,300,000 | 8.06 | 60,300,000 |
| October, | 809,900,000 | 26,100,000 | 20,600,000 | 37,400,000 | 7.93 | 51,800,000 |
| November, | 811,300,000 | 27,000,000 | 22,000,000 | 43,600,000 | 8.00 | 50,500,000 |
| December, | 1,001,800,000 | 32,300,000 | 25,100,000 | 54,500,000 | 8.28 | 54,800,000 |
| Total, | 11,134,700,000 | - | - | - | - | - |
| Average, | - | 30,500,000 | 24,600,000 | 46,100,000 | 8.26 | 59,300,000 |

## *Alewife Brook Pumping Station.*

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.
Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
Average duty for the year: 17,000,000 foot-pounds.
Average quantity raised each day: 3,451,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.
Coal used: first quality Cumberland, costing from $4.10 to $4.35 per ton.

*Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 114,724,000 | 3,701,000 | 2,881,000 | 5,882,000 | 13.24 | 18,800,000 |
| February, | 107,696,000 | 3,846,000 | 3,028,000 | 5,688,000 | 13.15 | 19,000,000 |
| March, | 163,396,000 | 5,271,000 | 3,622,000 | 7,403,000 | 12.65 | 22,800,000 |
| April, | 150,552,000 | 5,018,000 | 3,622,000 | 6,931,000 | 12.91 | 22,900,000 |
| May, | 116,261,000 | 3,750,000 | 2,881,000 | 6,931,000 | 13.10 | 18,800,000 |
| June, | 99,897,000 | 3,330,000 | 2,645,000 | 4,983,000 | 13.16 | 16,500,000 |
| July, | 102,482,000 | 3,306,000 | 2,456,000 | 5,688,000 | 13.01 | 16,400,000 |
| August, | 77,231,000 | 2,491,000 | 2,078,000 | 3,028,000 | 13.15 | 13,800,000 |
| September, | 68,522,000 | 2,284,000 | 1,952,000 | 3,430,000 | 13.16 | 13,200,000 |
| October, | 74,295,000 | 2,397,000 | 1,910,000 | 4,027,000 | 13.19 | 13,200,000 |
| November, | 81,875,000 | 2,729,000 | 2,036,000 | 4,799,000 | 13.13 | 14,400,000 |
| December, | 102,039,000 | 3,292,000 | 2,550,000 | 6,206,000 | 13.14 | 15,700,000 |
| Total, | 1,258,970,000 | - | - | - | - | - |
| Average, | - | 3,451,000 | 2,638,000 | 5,416,000 | 13.08 | 17,000,000 |

## South Metropolitan System.

### *Ward Street Pumping Station.*

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.
Average duty for the year: 87,200,000 foot-pounds.
Average quantity raised each day: 24,500,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief engineer, 1 machinist and 1 laborer.
Coal used: first quality Cumberland, costing $4.17 per ton.

*Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.*

| Months. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 749,900,000 | 25,900,000 | 20,600,000 | 36,300,000 | 40.75 | 108,900,000 |
| February, | 755,000,000 | 26,900,000 | 18,300,000 | 33,700,000 | 40.50 | 102,000,000 |
| March, | 1,016,000,000 | 32,800,000 | 23,400,000 | 41,000,000 | 42.20 | 99,900,000 |
| April, | 990,100,000 | 33,000,000 | 22,200,000 | 40,200,000 | 42.55 | 93,600,000 |
| May, | 860,300,000 | 27,800,000 | 19,400,000 | 42,500,000 | 41.00 | 95,700,000 |
| June, | 638,100,000 | 21,300,000 | 18,200,000 | 31,500,000 | 39.85 | 84,200,000 |
| July, | 663,400,000 | 21,400,000 | 17,300,000 | 31,500,000 | 40.45 | 87,200,000 |
| August, | 638,500,000 | 20,600,000 | 15,000,000 | 24,700,000 | 40.15 | 80,700,000 |
| September, | 680,300,000 | 22,700,000 | 15,000,000 | 28,300,000 | 39.85 | 79,300,000 |
| October, | 600,000,000 | 19,300,000 | 15,300,000 | 26,400,000 | 40.25 | 73,200,000 |
| November, | 666,000,000 | 22,200,000 | 16,200,000 | 29,800,000 | 40.10 | 71,700,000 |
| December, | 628,000,000 | 20,300,000 | 15,400,000 | 30,700,000 | 40.10 | 75,400,000 |
| Total | 8,885,600,000 | - | - | - | - | - |
| Average, | - | 24,500,000 | 18,000,000 | 33,000,000 | 40.65 | 87,200,000 |

Records from plunger displacement.
Average slip for the year about 15.2 per cent.

## *Quincy Pumping Station.*

At this station are two compound condensing Deane pumping engines.

**Contract capacity of pumps:** one, 3,000,000 gallons, the other, 5,000,000 gallons, with 36-foot lift.
**Average duty for the year:** 32,100,000 foot-pounds.
**Average quantity raised each day:** 3,528,000 gallons.
**Force employed:** 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.
**Coal used:** first quality Cumberland, costing from $4.50 to $6 per ton.

*Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.*

| Months. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| January, | 110,849,000 | 3,576,000 | 3,305,000 | 3,790,000 | 21.18 | 32,500,000 |
| February, | 102,813,000 | 3,672,000 | 3,427,000 | 4,158,000 | 21.16 | 33,200,000 |
| March, | 143,052,000 | 4,615,000 | 3,796,000 | 5,659,000 | 21.58 | 35,500,000 |
| April, | 139,638,000 | 4,655,000 | 3,842,000 | 5,256,000 | 22.48 | 37,600,000 |
| May, | 122,394,000 | 3,948,000 | 3,394,000 | 4,508,000 | 20.91 | 34,400,000 |
| June, | 112,596,000 | 3,753,000 | 3,273,000 | 4,336,000 | 21.19 | 33,700,000 |
| July, | 103,376,000 | 3,335,000 | 2,984,000 | 4,044,000 | 21.11 | 32,600,000 |
| August, | 93,004,000 | 3,000,000 | 2,716,000 | 3,261,000 | 20.99 | 30,800,000 |
| September, | 80,620,000 | 2,687,000 | 2,546,000 | 2,910,000 | 21.02 | 26,900,000 |
| October, | 87,419,000 | 2,820,000 | 2,467,000 | 3,261,000 | 21.22 | 26,000,000 |
| November, | 91,521,000 | 3,051,000 | 2,596,000 | 3,518,000 | 21.29 | 28,500,000 |
| December, | 100,050,000 | 3,227,000 | 2,999,000 | 3,741,000 | 20.87 | 33,000,000 |
| Total, | 1,287,332,000 | - | - | - | - | - |
| Average, | - | 3,528,000 | 3,112,000 | 4,037,000 | 21.25 | 32,100,000 |

## *Nut Island Screen House.*

The plant at the house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 33,600,000 gallons.
Total materials intercepted at screens during the past year, 1,247 cubic yards.
Materials intercepted per million gallons of sewage discharge, 2.75 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: 322 tons first quality Cumberland, costing from $3.59 to $3.95 per ton.

## Cost of Pumping.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: —

*Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.*

Volume (21,199.5 Million Gallons) × Lift (10.66 Feet) = 225,987 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $9,522 51 | $0.04214 |
| Coal, | 7,063 11 | .03125 |
| Oil, | 232 47 | .00103 |
| Waste, | 73 61 | .00033 |
| Water, | 808 80 | .00358 |
| Packing, | 259 73 | .00115 |
| Miscellaneous supplies and renewals, | 2,142 58 | .00948 |
| Totals, | $20,102 81 | $0.08896 |

*Average Cost per Million Foot-gallons for Pumping at the East Boston Station.*

Volume (20,469.5 Million Gallons) × Lift (16.59) = 339,589 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $9,470 93 | $0.02788 |
| Coal, | 9,134 78 | .02690 |
| Oil, | 280 04 | .00083 |
| Waste, | 48 15 | .00014 |
| Water, | 1,270 80 | .00374 |
| Packing, | 79 51 | .00023 |
| Miscellaneous supplies and renewals, | 1,634 43 | .00482 |
| Totals, | $21,918 64 | $0.06454 |

*Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.*

Volume (11,184.7 Million Gallons) × Lift (8.26 Feet) = 91,978 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $8,885 15 | $0.09661 |
| Coal, | 2,909 03 | .03163 |
| Oil, | 183 89 | .00200 |
| Waste, | 88 58 | .00096 |
| Water, | 364 80 | .00397 |
| Packing, | 111 91 | .00122 |
| Miscellaneous supplies and renewals, | 559 69 | .00608 |
| Totals, | $13,103 05 | $0.14247 |

*Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*

Volume (1,258.97 Million Gallons) × Lift (13.08 Feet) = 16,467 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $3,275 63 | $0.19892 |
| Coal, | 1,620 02 | .09838 |
| Oil, | 77 17 | .00469 |
| Waste, | 40 04 | .00243 |
| Water, | 162 60 | .00987 |
| Packing, | 53 88 | .00327 |
| Miscellaneous supplies and renewals, | 147 70 | .00897 |
| Totals, | $5,377 04 | $0.32653 |

*Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.*

Volume (8,885.6 Million Gallons) × Lift (40.65 Feet) = 361,190 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $12,002 90 | $0.03323 |
| Coal, | 7,893 88 | .02185 |
| Oil, | 812 78 | .00225 |
| Waste, | 93 29 | .00026 |
| Water, | 1,324 80 | .00367 |
| Packing, | 131 33 | .00036 |
| Miscellaneous supplies and renewals, | 2,300 21 | .00637 |
| Totals, | $24,559 19 | $0.06799 |

*Average Cost per Million Foot-gallons for Pumping at the Quincy Station.*

Volume (1,287.3 Million Gallons) × Lift (21.25 Feet) = 27,356 Million Foot-gallons.

| Items. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $4,020 60 | $0.14697 |
| Coal, | 1,475 33 | .05393 |
| Oil, | 23 04 | .00084 |
| Waste, | 14 00 | .00051 |
| Water, | 193 56 | .00708 |
| Packing, | 6 48 | .00024 |
| Miscellaneous supplies and renewals, | 464 74 | .01699 |
| Totals, | $6,197 75 | $0.22656 |

## Care of Special Structures.

### *Salt-water Pipe for supplying Condensers at East Boston Pumping Station.*

The existing salt-water pipes for this station were laid on the muddy bed of Chelsea Creek. The bed of this creek is changing, so that the pipes are constantly being covered with silt.

During the year a 10-inch pipe on a pile structure with platform at an elevation of about 4 feet above high water has been carried out to a point nearly 75 feet beyond the bulkhead line of Chelsea Creek, as established by the United States Government. The pipe is turned down at the end of this structure into a depth of water of about 8 feet at low tide, so as to remain submerged under extreme tidal conditions.

This work has been carried out under licenses granted by the Harbor and Land Commission and the United States Government.

The piles were furnished and driven by Lawler Brothers, contractors, and the remainder of the work carried out by the maintenance force.

### *Riprap Reinforcement at End of 60-inch Outlet Pipe for the South Metropolitan System.*

The strong tidal currents at the 60-inch outlet pipes in the harbor off Nut Island have occasioned some scouring of loose clay backfilling of the pipe trenches in that vicinity.

During the month of August the diving contractor who placed the pipes deposited 170 cubic yards of small riprap, in place of clay filling washed away.

The diver found no sand or other visible deposit from the sewage discharge on the bed of the harbor in the vicinity of the outfalls. He entered the pipes for a distance of 50 feet, and found the pipes entirely clean and in normal condition.

## South Metropolitan Outfalls.

The 60-inch outlet pipes in the harbor have been in operation twenty-six months at the date of this report. During the past year the average flow through them has been 33,600,000 gallons of sewage per day, with a maximum rate of 97,000,000 gallons at a time of melting snow.

## Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating matters, has during the year amounted to 2,141 cubic yards. This is equivalent to 2.8 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,942 cubic yards, equal to 6.5 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are satisfactorily free from deposit and in normal condition.

Respectfully submitted,

WM. M. BROWN,
*Engineer Sewerage Works.*

Boston, January 1, 1907.

# APPENDIX.

# Appendix No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | Amount of Bid. 4. Next to Lowest. | 5. Lowest. | 6. Contractor. |
|---|---|---|---|---|---|---|
| 1 | 195 | Wachusett Dam, . . | 11 | $1,640,870 00 | $1,603,635 00[1] | McArthur Brothers Company. |
| 2 | 245 | Section 2 of relocation of Central Massachusetts Railroad (extension of Contract No. 195). | –[2] | –[2] | –[2] | McArthur Brothers Company. |
| 3 | 288 | Pumping engine for the Arlington station. | 7 | 7,900 00 | 7,830 00 | Allis-Chalmers Co., Milwaukee, Wis. |
| 4 | 289[2] | Brass railing posts, Wachusett Dam. | 4 | 5,780 00 | 4,150 00[1] | J. H. McCafferty & Co., Boston, Mass. |
| 5 | 291[2] | Granite posts, curbing and edgestones for Wachusett Dam. | 6 | 1,741 00 | 1,700 00[1] | F. A. McCauliff, Fitchburg, Mass. |
| 6 | 293[2] | Steel gates and fencing at Wachusett Dam. | 5 | 1,485 00 | 1,349 00[1] | Henry Parsons & Son, Marlborough, Mass. |
| 7 | 294 | Arlington pumping station. | 5 | 29,098 00 | 28,328 00[1] | C. A. Dodge & Co., Boston. |
| 8 | 295 | Sterling filter beds, Sterling, Mass. | 5 | 10,230 50 | 9,808 50[1] | A. McKenzie & Co., Leominster, Mass. |
| 9 | 296[2] | Reinforced granolithic surface on Wachusett Dam. | –[2] | –[2] | –[2] | Simpson Brothers Corporation, Boston. |
| 10 | 8-M[2] | Remodelling and rebuilding attendant's house at Ashland Dam. | 3 | 1,365 00 | 1,200 00[1] | A. P. Eldridge, South Framingham, Mass. |
| 11 | 9-M | Repairing boiler at Chestnut Hill high-service pumping station. | 2 | 2,766 00 | 1,791 00[1] | Hodge Boiler Works, Boston. |

[1] Contract based upon this bid. [2] Competitive bids were not received on this contract.

# Appendix No. 1.

THE YEAR 1906 — WATER WORKS.

1906 have been given in previous reports.]

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1906. | 10. Value of Work done December 31, 1906. | |
|---|---|---|---|---|
| Oct. 1, '00, | Feb. 27, '06, | - - | $1,606,481 04 | 1 |
| April 18, '02, | Jan. 11, '06, | - - | 286,521 00 | 2 |
| Oct. 28, '05, | - | For whole work, $9,790, . . . . . . . | - | 3 |
| Sept. 8, '05, | Feb. 26, '06, | - - | 4,185 00 | 4 |
| Dec. 12, '05, | Mar. 7, '06, | - - | 1,700 00 | 5 |
| Feb. 3, '06, | Aug. 18, '06, | For whole work, $1,349, . . . . . . . | 1,349 00 | 6 |
| Aug. 23, '06, | - | For whole work, $28,328, . . . . . . . | 15,000 00 | 7 |
| Sept. 1, '06, | - | For earth excavation, $0.29 per cubic yard; for concrete masonry, $7.50 per cubic yard; for rubble stone masonry and paving, $2.70 per cubic yard; for furnishing and laying vitrified pipe: 18-inch, $1.50 per linear foot; 15-inch, $1.20 per linear foot; 12-inch, $0.90 per linear foot; 8-inch, $0.65 per linear foot; 6-inch, $0.60 per linear foot. | 9,900 00 | 8 |
| May 7, '06, | July 10, '06, | Cost of work plus $0.04 per square foot on each foot laid. | 2,452 72 | 9 |
| Aug. 15, '06, | Oct. 18, '06, | For whole work, $1,200, . . . . . . . | 1,200 00 | 10 |
| Nov. 28, '06, | - | For whole work, $1,791, . . . . . . . | - | 11 |

[1] Contract completed.

CONTRACTS MADE AND PENDING DURING THE

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | Amount of Bid. 4. Next to Lowest. | 5. Lowest. | 6. Contractor. |
|---|---|---|---|---|---|---|
| 1 | Special Order.[3] | 15 tons special castings, . | 3 | $59 00 per ton. | $57 50[1] per ton. | Warren Foundry and Machine Co., New York, N. Y. |
| 2 | Special Order. | Furnishing and erecting electric apparatus in gate-house at Wachusett Dam. | 3 | 888 23 | 864 00[1] | Frank Ridlon Co., Boston. |
| 3 | Special Order. | Hercules water wheel at Wachusett Dam. | 2 | 1,050 00 | 900 00[1] | Holyoke Machine Co., Holyoke, Mass. |
| 4 | Special Order. | Cut stone for retaining wall at the Arlington pumping station. | 4 | 637 00 | 598 00[1] | John Harrington, East Cambridge, Mass. |
| | | Total, . . . . . | . . | . . . | . . . | . . . . . |

[3] Contract completed.

YEAR 1906 — WATER WORKS — *Continued.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1906. | 10. Value of Work done December 31, 1906. | |
|---|---|---|---|---|
| April 4, '06, | Sept. 22, '06, | For all castings, $57.50 per ton of 2,000 pounds, . | $985 55 | 1 |
| June 7, '06, | - | For whole work, $864, . . . . . . . | 750 00 | 2 |
| Aug. 27, '06, | - | For whole work, $900, . . . . . . . | 800 00 | 3 |
| Nov. 16, '06, | - | For whole work, $598, . . . . . . . | 50 00 | 4 |
| . . . | . . . | . . . . . . . . . . . . | $1,951,324 31 | |

[1] Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING THE YEAR 1906 — WATER WORKS — *Concluded.*

## Summary of Contracts.[1]

| | Value of Work done December 31, 1906. |
|---|---|
| Wachusett Reservoir, 1 contract, | $9,900 00 |
| Relocation of Central Massachusetts Railroad, 1 contract, | 286,521 00 |
| Wachusett Dam, 5 contracts, | 1,616,167 76 |
| Distribution Department, 2 contracts, | 15,000 00 |
| Total of 9 contracts made and pending during the year 1906, | $1,927,588 76 |
| 282 contracts completed from 1896 to 1905, inclusive, | 13,716,781 17 |
| | $15,644,369 93 |
| Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston, | 512,000 00 |
| Total of 302 contracts, | $15,132,369 93 |

[1] In this summary, contracts charged to maintenance are excluded.

# Appendix No. 2.

**Table No. 1.**—*Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1906.*

| Place. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wachusett Watershed. Princeton, | 2.61 | 2.60 | 5.08 | 3.26 | 6.31 | 5.64 | 5.83 | 5.48 | 2.54 | 3.85 | 2.28 | 4.20 | 49.68 |
| Wachusett Watershed. Jefferson, | 2.86 | 2.81 | 5.42 | 3.56 | 7.18 | – | – | 4.55 | 2.94 | 4.73 | 2.04 | 4.28 | 40.37 |
| Wachusett Watershed. Sterling, | 2.33 | 2.50 | 4.60 | 2.63 | 6.27 | 5.98 | 4.34 | 4.54 | 2.34 | 4.03 | 2.01 | 4.37 | 45.94 |
| Wachusett Watershed. Boylston, | 2.54 | 3.03 | 5.56 | 3.04 | 6.57 | 6.24 | 6.40 | 2.79 | 2.64 | 3.19 | 2.66 | 4.18 | 48.84 |
| Sudbury Watershed. Sudbury Dam, | 2.33 | 2.78 | 6.12 | 2.80 | 5.40 | 3.87 | 3.45 | 2.43 | 2.90 | 3.12 | 2.48 | 4.36 | 42.04 |
| Sudbury Watershed. Framingham, | 2.50 | 2.88 | 6.13 | 2.72 | 5.25 | 3.38 | 3.13 | 2.64 | 2.91 | 3.11 | 2.50 | 4.39 | 41.54 |
| Sudbury Watershed. Ashland Dam, | 2.46 | 2.94 | 6.45 | 2.77 | 5.67 | 3.76 | 3.47 | 3.24 | 3.42 | 3.51 | 2.64 | 4.53 | 44.86 |
| Sudbury Watershed. Cordaville, | 2.59 | 3.07 | 6.56 | 3.25 | 6.33 | 4.63 | 3.63 | 3.77 | 3.99 | 3.85 | 3.12 | 4.68 | 49.47 |
| Lake Cochituate, | 2.66 | 2.59 | 6.47 | 2.60 | 4.98 | 3.44 | 3.04 | 2.37 | 2.84 | 3.26 | 2.50 | 4.68 | 41.43 |
| Chestnut Hill Reservoir, | 3.65 | 3.17 | 7.42 | 2.62 | 5.43 | 3.56 | 4.13 | 1.82 | 2.92 | 3.71 | 3.37 | 5.36 | 47.16 |
| Spot Pond, | 2.63 | 2.37 | 6.46 | 1.97 | 5.28 | 4.61 | 3.69 | 2.36 | 2.26 | 2.65 | 3.04 | 4.54 | 41.86 |
| Average of all, | 2.65 | 2.80 | 6.02 | 2.84 | 5.88 | 4.10 | 3.74 | 3.27 | 2.88 | 3.55 | 2.60 | 4.51 | 44.84 |
| Average, Wachusett watershed, | 2.59 | 2.74 | 5.17 | 3.12 | 6.58 | 5.95 | 5.52 | 4.34 | 2.61 | 3.95 | 2.25 | 4.26 | 49.08 |
| Average, Sudbury watershed, | 2.47 | 2.92 | 6.32 | 2.88 | 5.66 | 3.91 | 3.42 | 3.02 | 3.30 | 3.40 | 2.69 | 4.49 | 44.48 |

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1906.*

| DAY OF MONTH. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1, | - | - | - | - | - | No Records. | No Records. | - | - | - | - | - |
| 2, | - | - | - | - | - | | | - | - | - | - | 1 |
| 3, | 1 | - | 1 | - | 0.21 | | | - | 0.51 | - | - | 0.19[2] |
| 4, | 0.95[3] | - | 1.75 | 0.06 | - | | | 0.72 | - | - | - | - |
| 5, | - | - | - | 1 | 1 | | | - | - | 0.24 | - | - |
| 6, | 0.08[2] | - | - | 0.40 | 0.75 | | | 0.04 | - | - | - | 0.90[2] |
| 7, | - | - | - | - | - | | | - | - | - | - | - |
| 8, | 0.04[2] | - | - | - | - | | | 0.76 | - | - | - | - |
| 9, | - | 1.20[3] | 0.12[3] | 1 | 1 | | | - | - | 1.25 | - | 1 |
| 10, | - | - | - | 1 | 0.25 | | | 1 | - | - | - | 1 |
| 11, | - | - | 1 | 1.90[3] | - | | | 0.02 | - | - | 0.98[2] | 0.95[2] |
| 12, | 0.45 | - | 0.28[2] | - | - | | | - | - | - | - | - |
| 13, | - | - | - | - | - | | | - | - | - | - | - |
| 14, | 0.12[2] | 1 | - | - | - | | | - | - | - | - | - |
| 15, | - | 0.36[3] | 1 | 0.57 | - | | | - | - | - | 0.49[2] | 0.24 |
| 16, | 0.58 | - | 1.25[2] | - | - | | | - | - | - | - | - |
| 17, | - | - | - | - | 0.12 | | | - | - | - | 0.08 | - |
| 18, | 0.24[3] | - | - | - | - | | | - | - | - | - | - |
| 19, | - | - | 1 | - | - | | | - | 0.15 | - | - | - |
| 20, | 0.05 | - | 1.45[2] | - | - | | | 1 | 0.48 | 1.88 | - | 1 |
| 21, | - | 1 | - | - | - | | | 1.00 | 0.30 | - | 1 | 0.23 |
| 22, | - | 0.75 | - | - | - | | | 0.07 | 0.84 | - | 0.33 | 1 |
| 23, | 1 | - | - | 0.22 | - | | | 1 | - | - | - | 0.46[2] |
| 24, | 0.40 | - | - | - | 0.50 | | | 0.52 | - | - | - | - |
| 25, | - | 1 | - | - | 0.60 | | | - | - | 1.17 | - | - |
| 26, | - | 0.50 | 1 | - | - | | | - | - | - | 0.07 | - |
| 27, | - | - | 0.32 | - | 1 | | | 1.42 | 0.10 | - | - | - |
| 28, | - | - | - | - | 4.75 | | | - | - | - | 0.09[2] | - |
| 29, | - | - | - | - | - | | | - | - | - | - | - |
| 30, | - | - | 1 | 0.41 | - | | | - | 0.56 | 1 | - | 1 |
| 31, | - | - | 0.25 | - | - | | | - | - | 0.19 | - | 1.30 |
| Total, | 2.86 | 2.81 | 5.42 | 3.56 | 7.18 | | | 4.55 | 2.94 | 4.78 | 2.04 | 4.28 |

Total for the 10 months, 40.37 inches.

[1] Rainfall included in that of following day. [2] Snow. [3] Rain and snow.

TABLE NO. 3. — *Rainfall in Inches at Framingham, Mass., in 1906.*

| Day of Month. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1, | – | – | – | – | – | – | 0.01 | – | – | – | – | – |
| 2, | – | – | – | – | 0.13 | 0.02 | 0.47 | – | – | – | 0.08[3] | – |
| 3, | [1] | – | [1] | – | – | – | [1] | – | 0.04 | – | – | 0.05[2] |
| 4, | 1.00[3] | – | 2.20 | 0.03 | – | – | 1.02 | 0.48 | – | – | – | – |
| 5, | – | 0.04[3] | – | [1] | 0.04 | [1] | – | – | – | – | – | – |
| 6, | 0.02[2] | – | – | 0.28 | [1] | 0.27 | – | 0.22 | – | 0.07 | – | 0.74[3] |
| 7, | – | – | 0.04 | – | 0.60 | – | [1] | [1] | – | – | – | – |
| 8, | 0.05[2] | [1] | – | – | – | 0.01 | 0.06 | 0.16 | – | – | – | [1] |
| 9, | – | 1.18[3] | 0.47[3] | [1] | 0.11 | 0.14 | 0.02 | – | – | 1.06 | 0.06 | [1] |
| 10, | – | – | – | 1.59 | – | 0.11 | 0.17 | 0.05 | – | – | – | 0.60[3] |
| 11, | – | – | [1] | – | – | – | – | 0.02 | – | 0.01 | [1] | – |
| 12, | 0.14 | – | 0.20[2] | – | – | – | – | – | – | – | 1.26 | – |
| 13, | [1] | 0.02 | – | – | 0.12 | – | – | – | 0.09 | – | – | – |
| 14, | 0.28[2] | [1] | – | – | – | – | – | – | – | – | – | [1] |
| 15, | [1] | 0.51[3] | 1.26[2] | 0.49 | – | – | – | – | – | – | [1] | 0.18 |
| 16, | 0.50 | – | – | – | – | [1] | 0.04 | – | – | – | 0.94[3] | – |
| 17, | – | – | – | – | 0.05 | [1] | 0.21 | – | – | – | – | – |
| 18, | 0.09[3] | – | – | – | – | [1] | 0.17 | – | – | – | – | – |
| 19, | – | – | [1] | – | – | 1.38 | – | – | 0.05 | 0.08 | – | – |
| 20, | 0.08[3] | – | 1.31[3] | – | – | – | – | [1] | [1] | [1] | [1] | [1] |
| 21, | – | 0.69 | – | – | – | – | 0.06 | 0.06 | 0.65 | 1.07 | 0.10 | 0.46[3] |
| 22, | 0.01 | – | – | – | – | – | – | 0.38 | 0.78 | – | – | [1] |
| 23, | [1] | – | – | 0.19[3] | – | [1] | [1] | 0.29 | – | – | – | 0.35[2] |
| 24, | 0.34 | – | – | – | 0.24 | 0.26 | 0.31 | – | – | – | – | – |
| 25, | – | 0.44 | – | – | [1] | – | – | – | – | 0.28 | – | 0.14[2] |
| 26, | – | – | 0.05 | – | 0.24 | – | 0.04 | [1] | – | – | 0.04 | – |
| 27, | – | – | 0.16 | – | [1] | – | – | 0.98 | 0.08 | – | – | – |
| 28, | 0.04 | – | – | – | [1] | – | 0.01 | – | – | – | 0.06[3] | – |
| 29, | – | – | – | [1] | 3.72 | – | [1] | – | – | – | – | – |
| 30, | – | – | [1] | 0.14 | – | 1.19 | 0.54 | – | 1.22 | [1] | 0.01[3] | [1] |
| 31, | – | – | 0.44[3] | – | – | – | – | – | – | 0.59 | – | 1.87 |
| Total, | 2.50 | 2.88 | 6.13 | 2.72 | 5.25 | 3.38 | 3.13 | 2.64 | 2.91 | 3.11 | 2.50 | 4.39 |

Total for the year, 41.54 inches.

[1] Rainfall included in that of following day. [2] Snow. [3] Rain and snow.

TABLE NO. 4 — *Rainfall in Inches at Chestnut Hill Reservoir in 1906.*

| Date. | Amount. | Duration. | |
|---|---|---|---|
| Jan. 4, | 1.16[1] | 11.00 A.M. to | |
| Jan. 5, | | | 6.00 P.M. |
| Jan. 8, | 0.17[1] | 6.30 P.M. to | |
| Jan. 9, | | | 4.45 A.M. |
| Jan. 12, | 0.17 | 4.50 A.M. to | 2.45 P.M. |
| Jan. 14, | 0.59[1] | 5.15 A.M. to | 3.00 P.M. |
| Jan. 15, | 0.82 | 9.40 P.M. to | |
| Jan. 16, | | | 3.15 P.M. |
| Jan. 18, | 0.09 | 10.30 P.M. to | |
| Jan. 19, | | | 6.00 A.M. |
| Jan. 21, | 0.04 | 1.30 A.M. to | 5.00 A.M. |
| Jan. 22, | 0.58 | 9.00 P.M. to | |
| Jan. 23, | | | 6.30 A.M. |
| Jan. 27, | 0.06 | - | - |
| Jan. 28, | 0.02 | - | - |
| Total, | 3.65 | | |
| Feb. 9, | 1.33[2] | 3.05 A.M. to | 3.15 P.M. |
| Feb. 13, | 0.15 | 7.15 A.M. to | 5.00 P.M. |
| Feb. 14, | 0.40[2] | 3.45 P.M. to | |
| Feb. 15, | | | 1.00 A.M. |
| Feb. 21, | 0.88 | 2.50 P.M. to | |
| Feb. 22, | | | 12.50 A.M. |
| Feb. 25, | 0.41 | 9.00 P.M. to | |
| Feb. 26, | | | 12.25 A.M. |
| Total, | 3.17 | | |
| Mar. 3, | 2.63 | 10.30 A.M. to | |
| Mar. 4, | | | 5.20 A.M. |
| Mar. 7, | 0.09 | 1.45 P.M. to | |
| Mar. 8, | | | 2.25 A.M. |
| Mar. 9, | 0.48[1] | 7.15 A.M. to | 8.40 P.M. |
| Mar. 11, | 0.30[1] | 11.55 P.M. to | |
| Mar. 12, | | | 6.30 A.M. |
| Mar. 15, | 1.39[1] | 9.15 A.M. to | |
| Mar. 16, | | | 1.30 A.M. |
| Mar. 19, | 1.95[1] | 2.15 P.M. to | |
| Mar. 20, | | | 2.50 A.M. |
| Mar. 26, | 0.07 | 6.40 P.M. to | 11.50 P.M. |
| Mar. 27, | 0.11 | 8.05 A.M. to | 9.00 P.M. |
| Mar. 30, | 0.55 | 2.45 P.M. to | |
| Mar. 31, | | | 10.30 A.M. |
| Total, | 7.42 | | |
| Apr. 4, | 0.04 | 7.30 P.M. to | 10.15 P.M. |
| Apr. 5, | 0.32 | 11.35 P.M. to | |
| Apr. 6, | | | 6.20 A.M. |
| Apr. 9, | 1.09 | 6.15 P.M. to | |
| Apr. 10, | | | 11.30 A.M. |
| Apr. 10, | 0.25 | 8.30 P.M. to | |
| Apr. 11, | | | 1.40 A.M. |
| Apr. 15, | 0.48 | 1.30 A.M. to | 3.15 P.M. |
| Apr. 23, | 0.15 | 5.27 A.M. to | 4.00 P.M. |
| Apr. 30, | 0.29 | 3.50 A.M. to | 10.30 A.M. |
| Total, | 2.62 | | |
| May 2, | 0.18 | 5.20 P.M. to | 9.30 P.M. |
| May 5, | 0.88 | 1.30 P.M. to | |
| May 7, | | | 11.30 A.M. |
| May 9, | 0.20 | 6.30 P.M. to | |
| May 10, | | | 12.40 A.M. |
| May 13, | 0.08 | 7.45 P.M. to | |
| May 14, | | | 12.20 A.M. |
| May 24, | 0.12 | 6.00 P.M. to | 8.00 P.M. |
| May 25, | 0.13 | 6.00 P.M. to | 8.00 P.M. |
| May 27, | 3.89 | 2.40 P.M. to | |
| May 29, | | | 9.00 A.M. |
| Total, | 5.43 | | |

| Date. | Amount. | Duration. | |
|---|---|---|---|
| June 2, | 0.03 | 1.30 P.M. to | 2.00 P.M. |
| June 5, | 0.10 | 7.50 P.M. to | |
| June 6, | | | 7.00 A.M. |
| June 6, | 0.02 | 3.00 P.M. to | 3.30 P.M. |
| June 6, | 0.12 | 9.10 P.M. to | |
| June 7, | | | 1.00 P.M. |
| June 8, | 0.04 | 7.00 A.M. to | 9.15 A.M. |
| June 9, | 0.16 | 7.45 P.M. to | 11.35 P.M. |
| June 10, | 0.09 | 6.00 P.M. to | 9.00 P.M. |
| June 16, | 1.09 | 1.30 P.M. to | |
| June 19, | | | 9.30 A.M. |
| June 23, | 0.18 | 12.30 P.M. to | |
| June 24, | | | 12.40 A.M. |
| June 29, | 0.02 | 7.30 A.M. to | 11.00 A.M. |
| June 30, | 1.71 | 6.15 A.M. to | |
| July 1, | | | 7.00 A.M. |
| Total, | 3.56 | | |
| July 2, | 0.20 | 4.25 A.M. to | 7.10 A.M. |
| July 2, | 0.09 | 3.30 P.M. to | |
| July 3, | | | 2.50 A.M. |
| July 3, | 0.94 | 4.30 P.M. to | |
| July 4, | | | 5.30 P.M. |
| July 7, | 0.17 | 5.40 P.M. to | |
| July 8, | | | 6.00 A.M. |
| July 9, | 0.03 | 8.15 A.M. to | 10.00 A.M. |
| July 10, | 0.25 | 3.15 P.M. to | 5.40 P.M. |
| July 15, | 0.05 | 1.25 A.M. to | 5.10 A.M. |
| July 17, | 0.12 | 6.20 P.M. to | 7.30 P.M. |
| July 18, | 0.09 | 9.30 P.M. to | 10.10 P.M. |
| July 21, | 0.67 | 11.30 A.M. to | 10.30 P.M. |
| July 23, | 0.04 | 7.45 A.M. to | 2.00 P.M. |
| July 23, | 0.17 | 5.15 P.M. to | |
| July 24, | | | 5.40 A.M. |
| July 24, | 0.08 | 7.15 P.M. to | 9.30 P.M. |
| July 26, | 0.09 | 3.30 P.M. to | |
| July 27, | | | 2.45 A.M. |
| July 28, | 0.08 | 6.40 A.M. to | 7.40 P.M. |
| July 29, | 1.16 | 11.40 P.M. to | |
| July 30, | | | 8.00 A.M. |
| Total, | 4.13 | | |
| Aug. 2, | 0.09 | 8.30 P.M. to | |
| Aug. 3, | | | 11.30 A.M. |
| Aug. 3, | 0.39 | 7.40 P.M. to | |
| Aug. 4, | | | 7.25 P.M. |
| Aug. 6, | 0.02 | 3.45 P.M. to | 5.30 P.M. |
| Aug. 8, | 0.06 | 2.10 A.M. to | 5.10 A.M. |
| Aug. 8, | 0.10 | 8.30 A.M. to | 10.30 A.M. |
| Aug. 10, | 0.05 | 4.30 P.M. to | 8.30 P.M. |
| Aug. 21, | 0.05 | 2.00 A.M. to | 3.10 A.M. |
| Aug. 21, | 0.05 | 11.30 A.M. to | 12.25 P.M. |
| Aug. 23, | 0.35 | 9.05 P.M. to | |
| Aug. 24, | | | 5.00 A.M. |
| Aug. 27, | 0.03 | 1.10 A.M. to | 7.10 A.M. |
| Aug. 27, | 0.72 | 7.25 P.M. to | 11.30 P.M. |
| Total, | 1.82 | | |
| Sept. 3, | 0.10 | 4.10 A.M. to | 1.05 P.M. |
| Sept. 14, | 0.05 | 12.55 A.M. to | 5.05 A.M. |
| Sept. 20, | 0.68 | 10.10 P.M. to | |
| Sept. 21, | | | 7.00 A.M. |
| Sept. 22, | 0.74 | 11.00 A.M. to | 11.45 P.M. |
| Sept. 27, | 0.15 | 8.20 A.M. to | 3.15 P.M. |
| Sept. 30, | 1.20 | 2.25 A.M. to | 8.35 A.M. |
| Total, | 2.92 | | |

[1] Snow. [2] Rain and snow.

TABLE NO. 4.—*Rainfall in Inches at Chestnut Hill Reservoir in 1906*—Concluded.

| Date. | Amount. | Duration. |
|---|---|---|
| Oct. 6, . . | 0.16 | 3.30 P.M. to 8.20 P.M. |
| Oct. 9, . . | 1.80 | 4.55 P.M. to |
| Oct. 10, . . | | 9.30 A.M. |
| Oct. 20, . . | 0.55 | 2.40 P.M. to |
| Oct. 21, . . | | 7.15 A.M. |
| Oct. 25, . . | 0.24 | 5.45 A.M. to 12.00 M. |
| Oct. 30, . . | 0.96 | 12.30 P.M. to |
| Oct. 31, . . | | 7.30 P.M. |
| Total, . . | 3.71 | |
| Nov. 2, . . | 0.04 [1] | 4.45 A.M. to 11.30 A.M. |
| Nov. 9, . . | 0.06 | 11.20 P.M. to |
| Nov. 10, . . | | 1.10 A.M. |
| Nov. 11, . . | 1.42 | 9.50 A.M. to |
| Nov. 12, . . | | 2.15 A.M. |
| Nov. 15, . . | 1.47 [1] | 1.00 P.M. to |
| Nov. 16, . . | | 9.30 A.M. |
| Nov. 21, . . | 0.29 | 7.15 A.M. to |
| Nov. 22, . . | | 10.00 A.M. |
| Nov. 26, . . | 0.05 | 9.15 P.M. to 10.00 P.M. |
| Nov. 27, . . | 0.04 [1] | 10.00 A.M. to 9.00 P.M. |
| Total, . . | 3.37 | |
| Dec. 3, . . | 0.16 [2] | 8.00 A.M. to 5.20 P.M. |
| Dec. 6, . . | 0.74 [1] | 4.10 A.M. to 4.30 P.M. |
| Dec. 8, . . | 0.81 [1] | 10 00 P.M. to |
| Dec. 11, . . | | 3.15 A.M. |
| Dec. 15, . . | 0.28 | 3.05 A.M. to 7.00 P.M. |
| Dec. 20, . . | 0.64 | 4.00 P.M. to |
| Dec. 21, . . | | 5.00 P.M. |
| Dec. 22, . . | 0.64 [2] | 7.00 P.M. to |
| Dec. 23, . . | | 3.45 P.M. |
| Dec. 25, . . | 0.16 [2] | 8.00 A.M. to |
| Dec. 26, . . | | 1.25 A.M. |
| Dec. 31, . . | 0.04 | 2.12 A.M. to 5.15 A.M. |
| Dec. 31, . . | 1.89 | 8.15 A.M. to |
| Jan. 1, 1907, . | | 5.00 A.M. |
| Total, . | 5.36 | |

Total for the year, 47.16 inches.

[1] Rain and snow. [2] Snow.

TABLE NO. 5 — *Rainfall in Inches on the Wachusett Watershed, 1897 to 1906.*

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1897, . . . . . . | 3.46 | 2.86 | 4.01 | 2.32 | 5.06 | 5.11 | 8.65 | 3.47 | 1.93 | 0.94 | 7.62 | 6.41 | 51.84 |
| 1898, . . . . . . | 6.65 | 3.30 | 2.27 | 4.43 | 3.38 | 3.11 | 3.01 | 10.61 | 3.15 | 7.21 | 6.81 | 3.99 | 57.92 |
| 1899, . . . . . . | 2.93 | 5.12 | 6.75 | 1.94 | 1.33 | 5.51 | 3.82 | 3.20 | 4.11 | 2.72 | 1.94 | 2.03 | 41.40 |
| 1900, . . . . . . | 4.56 | 8.69 | 6.19 | 2.76 | 4.34 | 3.59 | 3.20 | 3.18 | 3.46 | 2.90 | 6.44 | 3.15 | 52.46 |
| 1901, . . . . . . | 1.75 | 1.13 | 5.82 | 9.64 | 7.02 | 1.51 | 5.66 | 4.58 | 3.10 | 3.70 | 2.43 | 9.36 | 55.70 |
| 1902, . . . . . . | 2.72 | 4.91 | 5.27 | 4.36 | 2.24 | 2.51 | 3.87 | 3.95 | 4.26 | 6.36 | 0.93 | 7.20 | 48.58 |
| 1903, . . . . . . | 2.85 | 4.42 | 6.58 | 3.10 | 1.24 | 10.37 | 3.43 | 3.88 | 2.93 | 4.43 | 2.36 | 3.99 | 49.58 |
| 1904, . . . . . . | 4.02 | 2.66 | 3.40 | 7.45 | 2.99 | 3.44 | 3.84 | 3.68 | 5.30 | 1.78 | 1.62 | 2.83 | 43.06 |
| 1905, . . . . . . | 6.10 | 1.72 | 3.95 | 2.60 | 0.83 | 4.88 | 5.39 | 3.09 | 6.90 | 1.81 | 2.52 | 3.79 | 43.58 |
| 1906, . . . . . . | 2.59 | 2.74 | 5.17 | 3.12 | 6.58 | 5.95 | 5.52 | 4.34 | 2.61 | 3.95 | 2.25 | 4.26 | 49.08 |
| Total, . . . . . | 37.63 | 37.55 | 49.41 | 41.72 | 35.01 | 45.98 | 46.39 | 43.98 | 37.75 | 35.80 | 34.92 | 47.06 | 493.20 |
| Average, . . . . | 3.76 | 3.75 | 4.94 | 4.17 | 3.50 | 4.60 | 4.64 | 4.40 | 3.78 | 3.58 | 3.49 | 4.71 | 49.32 |

NOTE. — The figures tabulated are means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1906, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1906.*

| Year. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1875, | 2.42 | 3.15 | 3.74 | 3.23 | 3.56 | 6.24 | 3.57 | 5.58 | 3.43 | 4.85 | 4.83 | 0.94 | 45.49 |
| 1876, | 1.83 | 4.21 | 7.43 | 4.20 | 2.76 | 2.04 | 9.13 | 1.72 | 4.62 | 2.24 | 5.76 | 3.62 | 49.56 |
| 1877, | 3.22 | 0.74 | 3.86 | 3.43 | 3.70 | 2.43 | 2.95 | 3.68 | 0.32 | 8.52 | 5.80 | 0.87 | 44.02 |
| 1878, | 5.63 | 5.97 | 4.69 | 5.79 | 0.96 | 3.88 | 2.97 | 6.94 | 1.29 | 6.42 | 7.02 | 6.37 | 57.98 |
| 1879, | 2.48 | 3.56 | 5.14 | 4.72 | 1.58 | 3.79 | 3.93 | 6.51 | 1.88 | 0.81 | 2.68 | 4.34 | 41.42 |
| 1880, | 3.57 | 3.98 | 3.31 | 3.11 | 1.34 | 2.14 | 6.27 | 4.01 | 1.60 | 3.74 | 1.78 | 2.83 | 38.18 |
| 1881, | 5.56 | 4.65 | 5.73 | 2.00 | 3.51 | 5.39 | 2.35 | 1.36 | 2.62 | 2.95 | 4.09 | 3.96 | 44.17 |
| 1882, | 5.95 | 4.55 | 2.65 | 1.82 | 5.07 | 1.66 | 1.77 | 1.67 | 8.74 | 2.07 | 1.15 | 2.30 | 39.40 |
| 1883, | 2.81 | 3.87 | 1.78 | 1.84 | 4.19 | 2.40 | 2.68 | 0.73 | 1.52 | 5.60 | 1.81 | 3.55 | 32.78 |
| 1884, | 5.09 | 6.54 | 4.72 | 4.41 | 3.47 | 3.44 | 3.67 | 4.65 | 0.85 | 2.48 | 2.65 | 5.17 | 47.14 |
| 1885, | 4.71 | 3.87 | 1.07 | 3.60 | 3.48 | 2.87 | 1.43 | 7.18 | 1.43 | 5.09 | 6.09 | 2.72 | 43.54 |
| 1886, | 6.36 | 6.28 | 3.61 | 2.22 | 3.00 | 1.47 | 3.27 | 4.10 | 2.90 | 3.24 | 4.64 | 4.97 | 46.06 |
| 1887, | 5.20 | 4.78 | 4.90 | 4.27 | 1.16 | 2.65 | 3.76 | 5.28 | 1.32 | 2.83 | 2.67 | 3.88 | 42.70 |
| 1888, | 4.15 | 3.68 | 6.02 | 2.43 | 4.32 | 2.54 | 1.41 | 6.22 | 8.59 | 4.99 | 7.22 | 5.40 | 57.47 |
| 1889, | 5.37 | 1.65 | 2.37 | 3.41 | 2.95 | 2.80 | 8.94 | 4.18 | 4.60 | 4.25 | 6.29 | 3.14 | 49.95 |
| 1890, | 2.53 | 3.51 | 7.73 | 2.64 | 5.21 | 2.03 | 2.46 | 3.87 | 6.00 | 10.51 | 1.20 | 5.31 | 53.00 |
| 1891, | 7.02 | 5.23 | 6.48 | 3.91 | 2.01 | 3.77 | 3.39 | 4.73 | 2.38 | 3.83 | 3.09 | 3.68 | 49.52 |
| 1892, | 5.85 | 3.14 | 4.06 | 0.83 | 5.58 | 2.76 | 4.23 | 4.44 | 2.84 | 1.17 | 5.80 | 1.18 | 41.83 |
| 1893, | 2.92 | 8.20 | 3.67 | 3.60 | 6.61 | 2.38 | 2.57 | 5.41 | 1.74 | 4.07 | 2.20 | 4.86 | 48.23 |
| 1894, | 4.09 | 3.91 | 1.43 | 3.42 | 4.24 | 1.15 | 3.26 | 2.03 | 2.63 | 5.34 | 3.43 | 4.81 | 39.74 |
| 1895, | 4.06 | 1.39 | 2.96 | 5.25 | 2.02 | 2.77 | 5.04 | 4.15 | 2.30 | 10.68 | 6.63 | 3.35 | 50.62 |
| 1896, | 2.39 | 7.18 | 5.24 | 1.57 | 2.57 | 3.22 | 2.51 | 2.40 | 7.72 | 3.76 | 3.02 | 2.12 | 43.70 |
| 1897, | 4.00 | 2.91 | 3.66 | 2.82 | 4.37 | 4.46 | 5.44 | 3.51 | 2.94 | 0.47 | 6.40 | 5.21 | 46.19 |
| 1898, | 6.83 | 4.49 | 2.40 | 4.66 | 3.22 | 2.48 | 4.09 | 8.17 | 2.62 | 6.71 | 6.93 | 3.28 | 55.88 |
| 1899, | 4.18 | 4.91 | 7.01 | 1.90 | 1.45 | 2.51 | 3.22 | 1.43 | 3.95 | 2.69 | 2.18 | 1.78 | 37.21 |
| 1900, | 4.96 | 9.14 | 6.35 | 2.58 | 4.32 | 2.99 | 2.42 | 2.26 | 3.36 | 3.83 | 5.70 | 2.74 | 50.65 |
| 1901, | 1.82 | 1.52 | 6.57 | 8.60 | 7.23 | 1.38 | 5.71 | 4.57 | 3.80 | 2.82 | 2.90 | 9.69 | 56.11 |
| 1902, | 2.52 | 6.18 | 5.34 | 4.13 | 1.86 | 2.89 | 2.94 | 3.40 | 4.54 | 4.44 | 1.45 | 6.38 | 46.07 |
| 1903, | 3.80 | 3.95 | 6.63 | 2.99 | 0.98 | 9.25 | 2.77 | 3.67 | 1.75 | 4.72 | 1.56 | 3.14 | 45.16 |
| 1904, | 4.87 | 3.00 | 2.72 | 8.87 | 2.65 | 2.80 | 1.96 | 3.86 | 5.80 | 1.64 | 1.73 | 2.92 | 42.82 |
| 1905, | 5.26 | 2.20 | 3.15 | 2.72 | 1.31 | 5.00 | 5.47 | 2.70 | 6.88 | 1.54 | 2.07 | 4.01 | 42.81 |
| 1906, | 2.47 | 2.92 | 6.32 | 2.88 | 5.66 | 3.91 | 3.42 | 3.02 | 3.30 | 3.40 | 2.69 | 4.49 | 44.48 |
| Total, | 133.92 | 135.26 | 147.26 | 113.85 | 107.29 | 101.49 | 119.00 | 127.38 | 109.76 | 131.70 | 123.46 | 122.96 | 1,473.33 |
| Average, | 4.19 | 4.22 | 4.60 | 3.56 | 3.35 | 3.17 | 3.72 | 3.98 | 3.43 | 4.12 | 3.86 | 3.84 | 46.04 |

[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1906, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1906.*

| MONTH. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | Mean for 10 Years, 1897-1906. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 796,000 | 1,563,000 | 2,092,000 | 796,000 | 519,000 | 1,676,000 | 1,265,000 | 659,000 | 1,266,000 | 1,132,000 | 1,177,000 |
| February, | 981,000 | 1,635,000 | 1,090,000 | 4,054,000 | 356,000 | 1,401,000 | 2,133,000 | 927,000 | 452,000 | 1,027,000 | 1,399,000 |
| March, | 2,760,000 | 3,068,000 | 2,776,000 | 3,722,000 | 2,718,000 | 3,992,000 | 3,423,000 | 3,008,000 | 3,004,000 | 1,860,000 | 3,085,000 |
| April, | 1,682,000 | 2,027,000 | 3,376,000 | 1,580,000 | 4,986,000 | 2,159,000 | 2,238,000 | 2,964,000 | 1,617,000 | 2,109,000 | 2,471,000 |
| May, | 1,168,000 | 1,390,000 | 862,000 | 1,882,000 | 2,729,000 | 1,081,000 | 569,000 | 1,498,000 | 445,000 | 1,533,000 | 1,260,000 |
| June, | 1,181,000 | 828,000 | 561,000 | 578,000 | 985,000 | 410,000 | 2,131,000 | 762,000 | 542,000 | 1,184,000 | 916,000 |
| July, | 1,442,000 | 383,000 | 354,000 | 217,000 | 477,000 | 292,000 | 624,000 | 497,000 | 365,000 | 728,000 | 538,000 |
| August, | 896,000 | 1,325,000 | 236,000 | 197,000 | 512,000 | 297,000 | 474,000 | 355,000 | 321,000 | 591,000 | 520,000 |
| September, | 380,000 | 676,000 | 250,000 | 127,000 | 320,000 | 241,000 | 375,000 | 494,000 | 1,228,000 | 277,000 | 437,000 |
| October, | 243,000 | 1,509,000 | 245,000 | 282,000 | 647,000 | 950,000 | 689,000 | 347,000 | 367,000 | 530,000 | 581,000 |
| November, | 1,283,000 | 2,170,000 | 430,000 | 875,000 | 517,000 | 635,000 | 634,000 | 343,000 | 442,000 | 749,000 | 808,000 |
| December, | 2,275,000 | 2,061,000 | 359,000 | 1,570,000 | 3,234,000 | 1,848,000 | 964,000 | 440,000 | 1,018,000 | 794,000 | 1,455,000 |
| Average for year, | 1,253,000 | 1,551,000 | 1,061,000 | 1,264,000 | 1,507,000 | 1,248,000 | 1,285,000 | 1,025,000 | 926,000 | 1,043,000 | 1,215,000 |
| Average for driest 6 months, | 886,000 | 1,018,000 | 312,000 | 377,000 | 576,000 | 471,000 | 626,000 | 413,000 | 541,000 | 618,000 | 630,000 |

[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, and to 5.1 per cent. in 1906.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1906.*

| MONTH. | 1875. | 1876. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 103,000 | 643,000 | 658,000 | 1,810,000 | 700,000 | 1,120,000 | 415,000 | 1,241,000 | 335,000 | 995,000 | 1,235,000 |
| February, | 1,496,000 | 1,368,000 | 949,000 | 2,465,000 | 1,711,000 | 1,787,000 | 1,546,000 | 2,403,000 | 1,088,000 | 2,842,000 | 1,354,000 |
| March, | 1,604,000 | 4,435,000 | 4,814,000 | 3,507,000 | 2,830,000 | 1,874,000 | 4,004,000 | 2,889,000 | 1,611,000 | 3,785,000 | 1,572,000 |
| April, | 3,049,000 | 3,292,000 | 2,394,000 | 1,626,000 | 3,116,000 | 1,169,000 | 1,546,000 | 867,000 | 1,350,000 | 2,853,000 | 1,815,000 |
| May, | 1,188,000 | 1,138,000 | 1,391,000 | 1,394,000 | 1,114,000 | 514,000 | 965,000 | 1,292,000 | 937,000 | 1,030,000 | 1,336,000 |
| June, | 870,000 | 222,000 | 597,000 | 506,000 | 413,000 | 175,000 | 1,338,000 | 529,000 | 300,000 | 416,000 | 426,000 |
| July, | 321,000 | 183,000 | 202,000 | 128,000 | 157,000 | 176,000 | 276,000 | 86,000 | 115,000 | 224,000 | 62,000 |
| August, | 396,000 | 405,000 | 121,000 | 476,000 | 395,000 | 119,000 | 148,000 | 55,000 | 79,000 | 257,000 | 240,000 |
| September, | 207,000 | 184,000 | 60,000 | 161,000 | 141,000 | 80,000 | 197,000 | 307,000 | 91,000 | 44,000 | 121,000 |
| October, | 646,000 | 234,000 | 631,000 | 516,000 | 71,000 | 102,000 | 186,000 | 299,000 | 186,000 | 83,000 | 336,000 |
| November, | 1,302,000 | 1,088,000 | 1,418,000 | 1,693,000 | 206,000 | 205,000 | 395,000 | 209,000 | 205,000 | 175,000 | 1,177,000 |
| December, | 584,000 | 453,000 | 1,290,000 | 3,177,000 | 463,000 | 175,000 | 775,000 | 315,000 | 194,000 | 925,000 | 1,174,000 |
| Average for year, | 972,000 | 1,135,000 | 1,214,000 | 1,452,000 | 894,000 | 578,000 | 979,000 | 862,000 | 533,000 | 1,129,000 | 901,000 |
| Average for driest 6 months, | 574,000 | 384,000 | 502,000 | 532,000 | 230,000 | 143,000 | 330,000 | 211,000 | 145,000 | 200,000 | 391,000 |

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1906* — Continued.

| MONTH. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 1,461,000 | 2,589,000 | 1,053,000 | 2,782,000 | 1,254,000 | 3,018,000 | 1,870,000 | 434,000 | 693,000 | 1,034,000 | 1,084,000 |
| February, | 4,801,000 | 2,829,000 | 1,950,000 | 1,196,000 | 1,529,000 | 3,486,000 | 943,000 | 1,542,000 | 991,000 | 541,000 | 2,676,000 |
| March, | 2,059,000 | 2,868,000 | 3,238,000 | 1,338,000 | 3,643,000 | 4,453,000 | 1,955,000 | 3,245,000 | 2,238,000 | 2,410,000 | 3,835,000 |
| April, | 1,947,000 | 2,620,000 | 2,645,000 | 1,410,000 | 1,875,000 | 2,397,000 | 871,000 | 2,125,000 | 1,640,000 | 2,515,000 | 1,494,000 |
| May, | 720,000 | 1,009,000 | 1,632,000 | 880,000 | 1,366,000 | 563,000 | 1,259,000 | 2,883,000 | 840,000 | 636,000 | 360,000 |
| June, | 203,000 | 418,000 | 421,000 | 653,000 | 568,000 | 418,000 | 428,000 | 440,000 | 419,000 | 174,000 | 399,000 |
| July, | 116,000 | 115,000 | 117,000 | 634,000 | 107,000 | 149,000 | 214,000 | 158,000 | 161,000 | 231,000 | 95,000 |
| August, | 94,000 | 214,000 | 379,000 | 1,452,000 | 132,000 | 163,000 | 280,000 | 181,000 | 209,000 | 229,000 | 57,000 |
| September, | 117,000 | 111,000 | 1,155,000 | 823,000 | 457,000 | 208,000 | 229,000 | 108,000 | 150,000 | 89,000 | 388,000 |
| October, | 146,000 | 190,000 | 1,999,000 | 1,230,000 | 2,272,000 | 210,000 | 126,000 | 222,000 | 374,000 | 1,379,000 | 592,000 |
| November, | 673,000 | 369,000 | 2,758,000 | 1,941,000 | 1,215,000 | 305,000 | 697,000 | 319,000 | 836,000 | 2,777,000 | 659,000 |
| December, | 1,020,000 | 643,000 | 3,043,000 | 2,241,000 | 996,000 | 544,000 | 485,000 | 796,000 | 716,000 | 1,782,000 | 657,000 |
| Average for year, | 1,087,000 | 1,154,000 | 1,697,000 | 1,383,000 | 1,285,000 | 1,315,000 | 781,000 | 1,087,000 | 770,000 | 1,152,000 | 1,019,000 |
| Average for driest 6 months, | 223,000 | 234,000 | 958,000 | 944,000 | 747,000 | 239,000 | 327,000 | 237,000 | 356,000 | 460,000 | 314,000 |

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1906* — Concluded.

| MONTH. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | Mean for 32 Years, 1875-1906. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 845,000 | 1,638,000 | 2,288,000 | 794,000 | 437,000 | 1,763,000 | 1,736,000 | 477,000 | 1,410,000 | 1,128,000 | 1,220,000 |
| February, | 1,067,000 | 3,022,000 | 1,381,000 | 3,800,000 | 300,000 | 1,674,000 | 2,279,000 | 882,000 | 330,000 | 1,041,000 | 1,788,000 |
| March, | 2,565,000 | 2,604,000 | 4,205,000 | 3,654,000 | 2,755,000 | 4,199,000 | 3,454,000 | 2,999,000 | 2,497,000 | 2,409,000 | 2,953,000 |
| April, | 1,515,000 | 1,829,000 | 2,521,000 | 1,350,000 | 4,204,000 | 1,885,000 | 2,261,000 | 3,294,000 | 1,643,000 | 1,949,000 | 2,096,000 |
| May, | 915,000 | 1,246,000 | 511,000 | 1,312,000 | 2,954,000 | 743,000 | 351,000 | 1,745,000 | 297,000 | 1,059,000 | 1,113,000 |
| June, | 962,000 | 530,000 | 66,000 | 316,000 | 753,000 | 303,000 | 1,987,000 | 419,000 | 467,000 | 707,000 | 526,000 |
| July, | 658,000 | 231,000 | 19,000 | —18,000 | 306,000 | 66,000 | 445,000 | 62,000 | 177,000 | 398,000 | 199,000 |
| August, | 591,000 | 1,107,000 | —35,000 | —34,000 | 424,000 | 135,000 | 307,000 | 170,000 | 114,000 | 180,000 | 282,000 |
| September, | 182,000 | 369,000 | 94,000 | 65,000 | 305,000 | 178,000 | 130,000 | 397,000 | 1,246,000 | 19,000 | 263,000 |
| October, | 94,000 | 1,160,000 | 115,000 | 186,000 | 412,000 | 506,000 | 492,000 | 191,000 | 158,000 | 301,000 | 489,000 |
| November, | 909,000 | 1,986,000 | 304,000 | 663,000 | 474,000 | 444,000 | 363,000 | 289,000 | 279,000 | 483,000 | 838,000 |
| December, | 1,584,000 | 1,799,000 | 220,000 | 1,096,000 | 2,695,000 | 1,779,000 | 582,000 | 269,000 | 887,000 | 659,000 | 1,063,000 |
| Average for year, | 991,000 | 1,450,000 | 973,000 | 1,082,000 | 1,342,000 | 1,140,000 | 1,190,000 | 931,000 | 795,000 | 860,000 | 1,065,000 |
| Average for driest six months, | 564,000 | 777,000 | 93,000 | 194,000 | 445,000 | 271,000 | 388,000 | 228,000 | 403,000 | 341,000 | 431,000 |

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 9.—*Wachusett System.—Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed above gaging station = 119.00 square miles.]

| MONTH. | Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).[1] | Quantity of Water wasted into River below Dam (Gallons per Day). | STORAGE.[2] Gain (Gallons per Day). | STORAGE.[2] Loss (Gallons per Day). | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|---|---|---|---|
| January, | 95,845,000 | 29,161,000 | 36,406,000 | - | 134,668,000 | 2.59 | 2.018 | 78.1 |
| February, | 99,246,000 | 2,732,000 | 20,175,000 | - | 122,154,000 | 2.74 | 1.654 | 60.5 |
| March, | 45,003,000 | 3,648,000 | 172,694,000 | - | 221,345,000 | 5.17 | 3.317 | 64.2 |
| April, | 83,063,000 | 4,367,000 | 163,510,000 | - | 250,940,000 | 3.12 | 3.640 | 116.5 |
| May, | 67,426,000 | 4,116,000 | 110,852,000 | - | 182,394,000 | 6.58 | 2.734 | 41.5 |
| June, | 84,690,000 | 4,230,000 | 51,927,000 | - | 140,847,000 | 5.95 | 2.043 | 34.3 |
| July, | 85,555,000 | 3,935,000 | - | 2,835,000 | 86,655,000 | 5.52 | 1.299 | 23.5 |
| August, | 92,574,000 | 4,365,000 | - | 26,590,000 | 70,348,000 | 4.34 | 1.055 | 24.3 |
| September, | 98,353,000 | 3,977,000 | - | 69,377,000 | 32,953,000 | 2.61 | 0.478 | 18.3 |
| October, | 69,794,000 | 4,048,000 | - | 10,816,000 | 63,061,000 | 3.95 | 0.945 | 23.9 |
| November, | 81,073,000 | 3,330,000 | 4,783,000 | - | 89,187,000 | 2.25 | 1.294 | 57.5 |
| December, | 69,768,000 | 3,306,000 | 21,465,000 | - | 94,539,000 | 4.26 | 1.417 | 33.3 |
| Total, | - | - | - | - | - | 49.08 | 21.894 | - |
| Average for year, | 80,777,000 | 3,761,000 | 39,521,000 | - | 124,059,000 | - | - | 44.6 |

[1] Including small quantities wasted in cleaning aqueduct.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE NO. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1906 inclusive = 75.2 square miles.]

| MONTH. | Quantity of Water received through Wachusett Aqueduct (Gallons per Day).[1] | Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).[2] | Quantity of Water discharged through Weston Aqueduct (Gallons per Day).[2] | Quantity of Water used by Framingham Water Company (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day). | Quantity of Water wasted into River below Lowest Dam (Gallons per Day). | STORAGE. Gain (Gallons per Day). | STORAGE. Loss (Gallons per Day). | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 95,345,000 | 91,139,000 | 33,781,000 | 542,000 | 1,713,000 | 44,781,000 | 8,213,000 | - | 84,823,000 | 2.47 | 2.012 | 81.5 |
| February, | 99,246,000 | 92,457,000 | 34,150,000 | 571,000 | 1,825,000 | 39,457,000 | 9,032,000 | - | 78,246,000 | 2.92 | 1.676 | 57.5 |
| March, | 45,003,000 | 81,819,000 | 33,271,000 | 565,000 | 2,245,000 | 109,348,000 | - | 1,094,000 | 181,152,000 | 6.32 | 4.297 | 68.1 |
| April, | 83,063,000 | 76,767,000 | 32,047,000 | 557,000 | 2,167,000 | 87,370,000 | 30,693,000 | - | 146,537,000 | 2.88 | 3.364 | 116.6 |
| May, | 67,426,000 | 65,223,000 | 32,713,000 | 568,000 | 1,216,000 | 22,026,000 | 25,342,000 | - | 79,661,000 | 5.66 | 1.890 | 33.4 |
| June, | 84,690,000 | 80,477,000 | 32,043,000 | 597,000 | 1,277,000 | 24,040,000 | - | 610,000 | 53,133,000 | 3.91 | 1.220 | 31.2 |
| July, | 85,555,000 | 70,223,000 | 31,768,000 | 590,000 | 1,055,000 | 13,587,000 | - | 1,765,000 | 29,903,000 | 3.42 | 0.709 | 20.7 |
| August, | 92,574,000 | 67,500,000 | 31,923,000 | 635,000 | 977,000 | 6,677,000 | - | 1,590,000 | 13,548,000 | 3.02 | 0.321 | 10.6 |
| September, | 98,353,000 | 75,880,000 | 31,573,000 | 650,000 | 697,000 | 1,507,000 | - | 10,490,000 | 1,463,000 | 3.30 | 0.034 | 1.0 |
| October, | 69,794,000 | 66,142,000 | 31,184,000 | 626,000 | 581,000 | 1,500,000 | - | 7,568,000 | 22,671,000 | 3.40 | 0.538 | 15.8 |
| November, | 81,073,000 | 70,683,000 | 31,347,000 | 607,000 | 880,000 | 10,393,000 | 3,483,000 | - | 36,320,000 | 2.69 | 0.834 | 31.1 |
| December, | 69,616,000 | 98,616,000 | 32,339,000 | 642,000 | 1,235,000 | 20,284,000 | - | 33,971,000 | 49,529,000 | 4.49 | 1.175 | 26.2 |
| Total, | - | - | - | - | - | - | - | - | - | 44.48 | 18.070 | - |
| Av. for year, | 80,764,000 | 77,981,000 | 32,336,000 | 596,000 | 1,319,000 | 31,694,000 | 1,534,000 | - | 64,697,000 | - | - | 40.6 |

[1] Not including quantities of water wasted in cleaning aqueduct, which were not discharged into Sudbury Reservoir.

[2] Including quantities of water wasted from aqueduct.

TABLE No. 11.— *Cochituate System.— Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed of lake = 18.87 square miles.[1]]

| Month. | Quantity of Water received from External Sources (Gallons per Day).[2] | Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day). | Quantity of Water wasted at Outlet (Gallons per Day). | Storage. Gain (Gallons per Day). | Storage. Loss (Gallons per Day). |
|---|---|---|---|---|---|---|
| January, | - | - | 894,000 | - | 15,726,000 | - |
| February, | - | - | 757,000 | - | 14,189,000 | - |
| March, | - | - | 1,213,000 | 27,055,000 | 8,529,000 | - |
| April, | - | 4,230,000 | 1,407,000 | 21,367,000 | 2,127,000 | - |
| May, | - | 19,094,000 | 797,000 | - | - | 2,874,000 |
| June, | 12,447,000 | 20,837,000 | 7,700,000 | - | 250,000 | - |
| July, | 9,768,000 | 22,765,000 | 561,000 | - | - | 5,755,000 |
| August, | - | 24,429,000 | 297,000 | - | - | 18,748,000 |
| September, | 9,480,000 | 23,293,000 | 1,933,000 | - | - | 8,780,000 |
| October, | - | 20,403,000 | 239,000 | - | - | 11,635,000 |
| November, | 4,647,000 | 15,597,000 | 360,000 | - | - | 2,510,000 |
| December, | 9,994,000 | 8,384,000 | 390,000 | - | 9,616,000 | - |
| Total, | - | - | - | - | - | - |
| Average for year, | 3,862,000 | 13,332,000 | 655,000 | 4,054,000 | - | 64,000 |

| Month. | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|
| January, | 16,619,000 | 2.66 | 1.57 | 59.0 |
| February, | 14,946,000 | 2.59 | 1.28 | 49.3 |
| March, | 36,797,000 | 6.47 | 3.48 | 53.8 |
| April, | 29,180,000 | 2.60 | 2.66 | 102.5 |
| May, | 17,016,000 | 4.98 | 1.61 | 32.3 |
| June, | 9,410,000 | 3.44 | 0.86 | 25.0 |
| July, | 7,808,000 | 3.04 | 0.74 | 24.3 |
| August, | 5,977,000 | 2.37 | 0.57 | 23.8 |
| September, | 5,227,000 | 2.84 | 0.48 | 16.8 |
| October, | 9,006,000 | 3.26 | 0.85 | 26.1 |
| November, | 8,800,000 | 2.50 | 0.80 | 32.2 |
| December, | 8,597,000 | 4.68 | 0.81 | 17.4 |
| Total, | - | 41.43 | 15.71 | - |
| Average for year, | 14,115,000 | - | - | 37.9 |

[1] Not including the watershed of Dudley Pond.

[2] From Framingham reservoirs Nos. 1, 2 and 3.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

| Date. | Chestnut Hill Reservoir. Ordinary High Water =134.00. | Lake Cochituate. High Water =144.36. | Farm Pond. High Water =159.25. | Spot Pond. High Water =163.00. | Weston Reservoir. High Water =200.00. | Framingham Reservoir. No. 1. Flash Boards 169.27. | Framingham Reservoir. No. 2. Flash Boards 177.12. | Framingham Reservoir. No. 3. Flash Boards 186.50. | Ashland Reservoir. Flash Boards 225.23. | Sudbury Reservoir. Flash Boards. 259.97. | Hopkinton Reservoir. Flash Boards 305.00. | Whitehall Reservoir. Ordinary High Water =337.91. | Wachusett Reservoir. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1, 1906, . | 132.87 | 138.68 | 158.77 | 163.14 | 199.91 | 167.87 | 176.17 | 182.06 | 220.91 | 256.97 | 295.74 | 337.27 | 344.06 |
| Feb. 1, 1906, . | 133.88 | 141.05 | 158.80 | 163.39 | 200.05 | 167.84 | 176.14 | 183.98 | 224.46 | 256.64 | 300.06 | 336.26 | 345.72 |
| Mar. 1, 1906, . | 133.95 | 142.84 | 158.88 | 163.38 | 200.02 | 167.86 | 176.17 | 184.00 | 224.58 | 257.01 | 302.95 | 335.82 | 346.55 |
| April 1, 1906, . | 133.98 | 143.93 | 159.23 | 162.96 | 200.11 | 168.12 | 176.37 | 181.90 | 223.56 | 257.18 | 303.35 | 336.11 | 354.47 |
| May 1, 1906, . | 133.97 | 144.18 | 159.14 | 163.09 | 199.99 | 167.66 | 176.46 | 182.36 | 224.59 | 258.84 | 304.28 | 336.69 | 361.14 |
| June 1, 1906, . | 133.36 | 143.83 | 159.10 | 163.05 | 200.09 | 169.45 | 177.59 | 183.32 | 225.48 | 259.64 | 305.08 | 337.48 | 365.23 |
| July 1, 1906, . | 133.65 | 143.86 | 158.90 | 163.22 | 200.12 | 168.62 | 177.68 | 184.02 | 225.44 | 259.42 | 305.07 | 337.81 | 367.20 |
| Aug. 1, 1906, . | 131.62 | 143.13 | 158.65 | 163.05 | 200.01 | 167.67 | 177.56 | 184.54 | 225.35 | 259.24 | 305.06 | 338.04 | 367.29 |
| Sept. 1, 1906, . | 132.70 | 140.51 | 158.20 | 162.98 | 200.06 | 169.35 | 177.54 | 184.18 | 225.28 | 259.08 | 305.08 | 338.04 | 366.57 |
| Oct. 1, 1906, . | 131.83 | 139.23 | 159.13 | 163.11 | 200.06 | 167.12 | 177.09 | 184.26 | 223.22 | 259.20 | 302.18 | 337.97 | 364.50 |
| Nov. 1, 1906, . | 133.18 | 137.34 | 158.83 | 163.04 | 200.04 | 168.42 | 177.06 | 184.39 | 221.03 | 259.10 | 299.29 | 338.20 | 363.84 |
| Dec. 1, 1906, . | 133.65 | 136.92 | 159.12 | 162.87 | 199.97 | 168.23 | 177.63 | 182.03 | 223.39 | 259.24 | 301.11 | 338.04 | 363.82 |
| Jan. 1, 1907, . | 134.46 | 138.56 | 159.22 | 162.89 | 200.26 | 168.31 | 176.56 | 183.69 | 224.80 | 256.45 | 303.00 | 337.05 | 364.57 |

TABLE NO. 13.—*Average Daily Quantity of Water flowing through Aqueducts in 1906 by Months.*[1]

| MONTH. | Wachusett Aqueduct into Sudbury Reservoir (Gallons). | Weston Aqueduct into Metropolitan District (Gallons). | SUDBURY AQUEDUCT INTO CHESTNUT HILL RESERVOIR. | | | Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons). |
|---|---|---|---|---|---|---|
| | | | From Framingham Reservoir No. 3 (Gallons). | From Framingham Reservoirs Nos. 1 and 2 (Gallons). | Total (Gallons). | |
| January, | 95,845,000 | 33,781,000 | 91,139,000 | - | 91,139,000 | - |
| February, | 99,246,000 | 34,150,000 | 87,007,000 | 5,450,000 | 92,457,000 | - |
| March, | 45,008,000 | 32,716,000 | 81,819,000 | - | 81,819,000 | - |
| April, | 83,063,000 | 32,047,000 | 76,767,000 | - | 76,767,000 | 3,707,000 |
| May, | 67,426,000 | 32,713,000 | 48,232,000 | 16,229,000 | 64,461,000 | 19,094,000 |
| June, | 84,690,000 | 32,043,000 | 67,323,000 | - | 67,323,000 | 20,837,000 |
| July, | 85,555,000 | 31,768,000 | 60,116,000 | 339,000 | 60,455,000 | 22,765,000 |
| August, | 92,574,000 | 31,923,000 | 61,500,000 | 6,000,000 | 67,500,000 | 24,429,000 |
| September, | 98,358,000 | 31,573,000 | 57,113,000 | 9,287,000 | 66,400,000 | 23,293,000 |
| October, | 69,794,000 | 31,184,000 | 39,423,000 | 26,719,000 | 66,142,000 | 20,406,000 |
| November, | 81,073,000 | 31,347,000 | 62,790,000 | 3,247,000 | 66,037,000 | 15,597,000 |
| December, | 69,616,000 | 32,339,000 | 88,623,000 | - | 88,623,000 | 8,384,000 |
| Average, | 80,764,000 | 32,289,000 | 68,363,000 | 5,634,000 | 73,997,000 | 13,258,000 |

[1] Not including quantities wasted while cleaning and repairing aqueducts, and not including 3,868,000 gallons per day diverted through the Sudbury Aqueduct to Lake Cochituate, and 270,000 gallons per day diverted to Farm Pond.

TABLE NO. 14.—*Statement of Operations of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

| Month. | Engine No. 1. Total Pumping Time. | | Engine No. 1. Amount pumped, corrected for Slip (Million Gallons). | Engine No. 2. Total Pumping Time. | | Engine No. 2. Amount pumped, corrected for Slip (Million Gallons). | Total Amount pumped (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hrs. | Min. | | Hrs. | Min. | | | | | | | No. 1. | No. 2. | | |
| January, | 491 | 10 | 171.77 | - | - | - | 171.77 | 211,289 | 22,721 | 10.8 | 812.96 | 119.09 | - | 80,650,000 | 83,160,000 |
| February, | 458 | 05 | 160.18 | 8 | 05 | 2.82 | 163.00 | 234,344 | 23,190 | 9.9 | 695.56 | 119.46 | 120.88 | 69,220,000 | 71,370,000 |
| March, | 390 | 05 | 128.26 | 43 | 50 | 14.17 | 142.43 | 241,598 | 26,437 | 10.9 | 589.58 | 118.60 | 119.68 | 58,300,000 | 60,110,000 |
| April, | 501 | 30 | 167.13 | 135 | 30 | 44.57 | 211.70 | 324,465 | 40,360 | 12.4 | 652.46 | 122.95 | 126.94 | 67,280,000 | 69,370,000 |
| May, | 362 | 20 | 122.35 | 206 | 40 | 73.17 | 195.52 | 287,958 | 34,604 | 12.0 | 678.99 | 123.07 | 121.71 | 69,320,000 | 71,480,000 |
| June, | 199 | 15 | 69.12 | 376 | 40 | 129.16 | 198.28 | 296,290 | 38,194 | 12.9 | 669.21 | 119.75 | 120.53 | 67,040,000 | 69,120,000 |
| July, | 519 | 05 | 175.28 | 37 | 35 | 13.50 | 188.78 | 285,700 | 33,369 | 11.7 | 660.76 | 120.86 | 127.36 | 66,780,000 | 68,860,000 |
| August, | 180 | 25 | 59.20 | 294 | 20 | 95.19 | 154.39 | 244,435 | 30,650 | 12.5 | 631.62 | 121.58 | 121.69 | 64,000,000 | 65,990,000 |
| September, | - | - | - | 487 | - | 160.58 | 160.58 | 255,558 | 29,470 | 11.5 | 628.35 | - | 120.98 | 63,320,000 | 65,290,000 |
| October, | - | - | - | 348 | 45 | 112.92 | 112.92 | 207,834 | 24,033 | 11.6 | 543.32 | - | 121.38 | 54,930,000 | 56,640,000 |
| November, | 50 | 45 | 17.57 | 98 | 30 | 34.09 | 51.66 | 139,036 | 16,955 | 12.2 | 371.56 | 120.04 | 121.03 | 37,350,000 | 38,510,000 |
| December, | 318 | 15 | 111.93 | 118 | 30 | 42.15 | 154.08 | 286,270 | 34,442 | 12.0 | 538.23 | 120.52 | 121.05 | 54,100,000 | 55,780,000 |
| Total, | 3,470 | 55 | 1,182.79 | 2,155 | 25 | 722.32 | 1,905.11 | 3,014,777 | 354,425 | - | - | - | - | - | - |
| Average, | - | - | - | - | - | - | - | - | - | 11.8 | 631.92 | 120.62 | 121.60 | 63,690,000 | 65,670,000 |

TABLE NO. 15. — *Statement of Operations of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[7.5 per cent. allowed for slip.]

| Month. | Total Pumping Time. Hrs. | Total Pumping Time. Min. | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|
| January, | - | - | - | - | - | - | - | - | - | - |
| February, | 24 | 55 | 23.37 | 22,127 | 2,235 | 10.1 | 1,056.17 | 127.79 | 112,430,000 | 121,480,000 |
| March, | - | - | - | - | - | - | - | - | - | - |
| April, | 282 | 15 | 264.21 | 272,979 | 33,028 | 12.1 | 967.88 | 128.32 | 103,460,000 | 111,790,000 |
| May, | 47 | 10 | 44.20 | 43,944 | 5,149 | 11.7 | 1,005.83 | 127.22 | 106,590,000 | 115,170,000 |
| June, | 23 | 55 | 22.45 | 24,100 | 3,078 | 12.8 | 931.54 | 128.70 | 99,870,000 | 107,910,000 |
| July, | 119 | 05 | 111.80 | 109,089 | 13,024 | 11.9 | 1,024.85 | 128.97 | 110,100,000 | 118,960,000 |
| August, | 48 | 55 | 45.42 | 42,887 | 5,351 | 12.5 | 1,059.06 | 129.48 | 114,230,000 | 123,430,000 |
| September, | - | - | - | - | - | - | - | - | - | - |
| October, | 2 | 55 | 2.77 | 3,807 | 437 | 11.5 | 727.61 | 124.59 | 75,510,000 | 81,590,000 |
| November, | - | - | - | - | - | - | - | - | - | - |
| December, | - | - | - | - | - | - | - | - | - | - |
| Total, | 549 | 10 | 514.22 | 518,983 | 62,302 | - | - | - | - | - |
| Average, | - | - | - | - | - | 12.0 | 900.91 | 128.44 | 106,020,000 | 114,550,000 |

TABLE No. 16.—*Statement of Operations of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

| Month. | Total Pumping Time. Hrs. | Total Pumping Time. Min. | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. | Summary of Engines Nos. 1, 2, 3 and 4. Total Amount pumped, corrected for Slip (Million Gallons). | Summary of Engines Nos. 1, 2, 3 and 4. Daily Average Amount pumped (Million Gallons). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 739 | 10 | 937.09 | 764,012 | 84,606 | 11.1 | 1,226.54 | 129.94 | 132,760,000 | 136,840,000 | 1,108.86 | 35.770 |
| February, | 647 | 25 | 817.84 | 645,876 | 64,387 | 10.0 | 1,266.25 | 130.75 | 137,910,000 | 142,150,000 | 1,004.21 | 35.865 |
| March, | 744 | - | 942.00 | 757,323 | 84,081 | 11.1 | 1,243.86 | 129.94 | 134,640,000 | 138,780,000 | 1,084.43 | 34.982 |
| April, | 434 | 20 | 544.99 | 462,388 | 61,676 | 13.3 | 1,178.64 | 130.92 | 128,540,000 | 132,490,000 | 1,020.90 | 34.030 |
| May, | 694 | 35 | 872.14 | 736,977 | 89,239 | 12.1 | 1,183.40 | 132.43 | 130,550,000 | 134,560,000 | 1,111.86 | 35.866 |
| June, | 694 | 10 | 874.04 | 727,687 | 93,794 | 12.9 | 1,201.12 | 131.73 | 131,800,000 | 135,850,000 | 1,094.77 | 36.492 |
| July, | 615 | 30 | 769.64 | 644,130 | 74,291 | 11.5 | 1,194.85 | 132.37 | 131,750,000 | 135,800,000 | 1,070.22 | 34.523 |
| August, | 694 | 30 | 869.49 | 737,526 | 92,808 | 12.6 | 1,178.93 | 132.45 | 130,070,000 | 134,070,000 | 1,069.30 | 34.494 |
| September, | 716 | 45 | 892.99 | 740,756 | 85,079 | 11.5 | 1,205.51 | 132.26 | 132,810,000 | 136,890,000 | 1,053.57 | 35.119 |
| October, | 737 | 25 | 925.12 | 792,880 | 91,464 | 11.5 | 1,166.78 | 132.85 | 129,120,000 | 133,090,000 | 1,040.81 | 33.575 |
| November, | 720 | - | 916.72 | 759,585 | 98,126 | 12.9 | 1,206.87 | 131.72 | 132,420,000 | 136,490,000 | 968.38 | 32.279 |
| December, | 743 | 35 | 948.75 | 749,397 | 90,161 | 12.0 | 1,266.02 | 131.46 | 138,640,000 | 142,900,000 | 1,102.83 | 35.575 |
| Total, | 8,181 | 52 | 10,310.81 | 8,518,537 | 1,009,712 | - | - | - | - | - | - | - |
| Average, | - | - | - | - | - | 11.9 | 1,210.40 | 131.57 | 132,660,000 | 136,740,000 | 12,730.14 | 34.877 |

TABLE NO. 17. — *Statement of Operations of Engines Nos. 5, 6 and 7 at Chestnut Hill Low-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

| Month. | Engine No. 5. | | Engine No. 6. | | Engine No. 7. | | Total Amount pumped (Million Gallons). | Daily Average Amount pumped (Million Gallons). | Total Amount of Coal consumed (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | | | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Pumping Time. | Amount pumped, corrected for Slip (Million Gallons). | Total Pumping Time. | Amount pumped, corrected for Slip (Million Gallons). | Total Pumping Time. | Amount pumped, corrected for Slip (Million Gallons). | | | | | | Engine No. 5. | Engine No. 6. | Engine No. 7. | | |
| | Hrs. Min. | | Hrs. Min. | | Hrs. Min. | | | | | | | | | | | |
| January, | 732 - | 866.86 | 400 15 | 463.95 | 300 10 | 359.56 | 1,690.87 | 54.528 | 748,435 | 13.2 | 2,258.54 | 53.76 | 54.69 | 52.84 | 101,250,000 | 104,340,000 |
| February, | 635 55 | 800.88 | 649 25 | 822.21 | - - | - | 1,624.09 | 58.003 | 696,995 | 13.5 | 2,330.13 | 54.05 | 53.69 | - | 104,560,000 | 107,750,000 |
| March, | 639 55 | 792.92 | 609 55 | 749.74 | - - | - | 1,542.66 | 49.763 | 611,030 | 12.7 | 2,524.69 | 47.56 | 47.37 | - | 99,830,000 | 102,870,000 |
| April, | 529 50 | 650.07 | 649 20 | 806.40 | - - | - | 1,456.47 | 48.549 | 536,093 | 11.4 | 2,716.82 | 47.69 | 45.88 | - | 105,660,000 | 108,880,000 |
| May, | 289 05 | 321.92 | 666 25 | 765.09 | 405 20 | 482.12 | 1,569.18 | 50.617 | 627,875 | 13.2 | 2,499.10 | 47.72 | 48.41 | 50.82 | 102,020,000 | 105,130,000 |
| June, | 267 25 | 306.34 | 355 45 | 432.04 | 665 45 | 794.80 | 1,583.18 | 51.106 | 639,900 | 12.9 | 2,395.97 | 53.39 | 54.70 | 53.22 | 107,120,000 | 110,300,000 |
| July, | 25 - | 32.94 | 606 45 | 745.75 | 614 30 | 760.78 | 1,539.47 | 49.660 | 648,525 | 13.7 | 2,373.80 | 47.84 | 51.72 | 51.23 | 101,630,000 | 104,730,000 |
| August, | 724 35 | 817.44 | 4 40 | 6.07 | 703 40 | 792.90 | 1,616.50 | 52.145 | 701,750 | 13.9 | 2,303.53 | 52.90 | 48.55 | 52.87 | 101,450,000 | 104,540,000 |
| September, | 695 30 | 809.26 | 438 10 | 517.20 | 231 - | 267.39 | 1,593.85 | 53.128 | 684,790 | 12.5 | 2,327.50 | 52.91 | 53.78 | 51.05 | 101,900,000 | 105,010,000 |
| October, | 590 15 | 754.27 | 530 35 | 674.49 | 77 15 | 88.78 | 1,517.54 | 48.953 | 622,480 | 14.2 | 2,437.89 | 49.67 | 49.07 | 51.12 | 100,500,000 | 103,570,000 |
| November, | 427 10 | 532.23 | 153 10 | 184.55 | 550 55 | 681.80 | 1,398.58 | 46.619 | 589,320 | 15.1 | 2,373.21 | 45.81 | 45.67 | 46.26 | 90,960,000 | 93,730,000 |
| December, | 415 35 | 509.75 | 640 30 | 781.83 | 467 - | 565.17 | 1,856.75 | 59.895 | 848,165 | 14.0 | 2,180.14 | 58.28 | 53.01 | 53.29 | 100,150,000 | 103,200,000 |
| Total, | 5,972 15 | 7,194.88 | 5,704 55 | 6,950.33 | 4,015 35 | 4,793.39 | 18,988.59 | - | 7,955,358 | - | - | - | - | - | - | - |
| Average, | - | - | - | - | - | - | - | 51.887 | - | 13.4 | 2,330.61 | 51.36 | 50.78 | 51.48 | 101,430,000 | 104,520,000 |

TABLE NO. 18. — *Statement of Operations of Engines Nos. 8 and 9 at Spot Pond Pumping Station for the Year 1906.*

[Engine No. 8, 2.02 per cent. allowed for slip.]

| Month. | Total Pumping Time. Hrs. | Total Pumping Time. Min. | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or Lighting. | Summary for Engines Nos. 8 and 9. Total Amount pumped, corrected for Slip (Million Gallons). | Summary for Engines Nos. 8 and 9. Daily Average Amount pumped (Million Gallons). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| December, | 12 | 45 | 6.02 | 5,545 | - | - | 1,085.66 | 129.30 | 116,930,000 | 119,340,000 | - | - |
| Total and average, | 12 | 45 | 6.02 | 5,545 | - | - | 1,085.66 | 129.30 | 116,930,000 | 119,340,000 | - | - |

[Engine No. 9, 3 per cent. allowed for slip.]

| Month. | Total Pumping Time. Hrs. | Total Pumping Time. Min. | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or Lighting. | Summary for Engines Nos. 8 and 9. Total Amount pumped, corrected for Slip (Million Gallons). | Summary for Engines Nos. 8 and 9. Daily Average Amount pumped (Million Gallons). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 287 | - | 231.40 | 187,651 | 22,174 | 11.8 | 1,233.14 | 128.21 | 131,700,000 | 135,880,000 | 231.40 | 7.465 |
| February, | 265 | - | 212.83 | 175,699 | 21,339 | 12.1 | 1,211.33 | 127.54 | 128,690,000 | 132,720,000 | 212.83 | 7.601 |
| March, | 289 | 15 | 231.91 | 191,059 | 24,456 | 12.8 | 1,213.81 | 127.76 | 129,180,000 | 133,230,000 | 231.91 | 7.481 |
| April, | 265 | 20 | 208.92 | 171,324 | 22,112 | 12.9 | 1,219.44 | 124.66 | 126,630,000 | 130,600,000 | 208.92 | 6.964 |
| May, | 379 | 45 | 281.14 | 241,272 | 34,732 | 14.4 | 1,165.24 | 128.38 | 124,610,000 | 128,520,000 | 281.14 | 9.069 |
| June, | 336 | 15 | 267.98 | 228,129 | 38,249 | 16.8 | 1,174.69 | 128.62 | 125,860,000 | 129,800,000 | 267.98 | 8.933 |
| July, | 354 | - | 284.77 | 244,147 | 37,470 | 15.3 | 1,166.39 | 127.41 | 123,790,000 | 127,670,000 | 284.77 | 9.186 |
| August, | 369 | 45 | 296.91 | 250,744 | 34,824 | 13.9 | 1,184.12 | 127.44 | 125,700,000 | 129,640,000 | 296.91 | 9.578 |
| September, | 359 | 45 | 287.83 | 227,937 | 22,873 | 10.0 | 1,262.76 | 128.19 | 134,840,000 | 139,070,000 | 287.83 | 9.594 |
| October, | 309 | 45 | 250.27 | 207,303 | 23,568 | 11.4 | 1,207.27 | 128.99 | 129,720,000 | 133,790,000 | 250.27 | 8.073 |
| November, | 281 | 45 | 226.36 | 189,240 | 22,189 | 11.7 | 1,196.15 | 128.99 | 128,520,000 | 132,550,000 | 226.36 | 7.545 |
| December, | 306 | 15 | 245.43 | 212,999 | 22,416 | 10.3 | 1,152.26 | 129.09 | 123,900,000 | 127,780,000 | 251.45 | 8.111 |
| Total, | 3,803 | 50 | 3,025.75 | 2,527,504 | 326,402 | - | - | - | - | - | 3,081.77 | - |
| Average, | - | - | - | - | - | 12.9 | 1,197.13 | 127.98 | 127,620,000 | 131,620,000 | - | 8.306 |

TABLE No. 19.—*Average Daily Consumption of Water during the Year 1906, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont, Nahant and a Small Portion of Saugus. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 23.)*

| MONTH. | Average Daily Consumption (Gallons). | Estimated Population. | Consumption per Inhabitant (Gallons). |
|---|---|---|---|
| January, | 119,697,300 | 907,040 | 132 |
| February, | 123,351,700 | 907,950 | 136 |
| March, | 117,477,900 | 908,850 | 129 |
| April, | 112,039,000 | 909,760 | 123 |
| May, | 116,444,700 | 912,670 | 128 |
| June, | 118,834,000 | 915,570 | 130 |
| July, | 116,620,500 | 918,210 | 127 |
| August, | 118,389,300 | 919,850 | 129 |
| September, | 118,196,500 | 920,490 | 129 |
| October, | 112,341,300 | 920,130 | 122 |
| November, | 109,952,800 | 919,770 | 119 |
| December, | 127,156,000 | 921,410 | 138 |
| For the year, | 117,524,600 | 915,040 | 128 |

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 16,250,000 gallons, equivalent to a daily average rate of 45,000 gallons.

TABLE No. 20.—*Average Daily Consumption of Water, in Gallons, from the Low-service System in 1906.*

| MONTH. | SOUTHERN LOW SERVICE. | NORTHERN LOW SERVICE. | Total Low-service Consumption. |
|---|---|---|---|
| | Boston, excluding East Boston and Charlestown. | Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington. | |
| January, | 48,851,900 | 27,732,500 | 76,584,400 |
| February, | 50,872,800 | 29,026,100 | 79,898,900 |
| March, | 47,919,700 | 26,945,400 | 74,865,100 |
| April, | 45,426,300 | 25,072,400 | 70,498,700 |
| May, | 45,930,900 | 25,479,600 | 71,410,500 |
| June, | 46,923,000 | 25,811,000 | 72,734,000 |
| July, | 46,701,600 | 25,722,500 | 72,424,100 |
| August, | 47,259,600 | 26,383,000 | 73,642,600 |
| September, | 47,026,700 | 25,799,900 | 72,826,600 |
| October, | 46,494,800 | 24,078,600 | 70,573,400 |
| November, | 46,598,300 | 23,216,900 | 69,815,200 |
| December, | 53,367,100 | 29,932,400 | 83,299,500 |
| For the year, | 47,769,800 | 26,258,200 | 74,028,000 |

TABLE NO. 21. — *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1906.*

| Month. | Southern High Service. Quincy, Watertown, Belmont, and Portions of Boston and Milton. | Southern Extra High Service. Portions of Boston and Milton. | Northern High Service. Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford, Somerville and Saugus. | Northern Extra High Service. Lexington and Portion of Arlington. |
|---|---|---|---|---|
| January, | 34,363,200 | 651,900 | 7,558,800 | 539,000 |
| February, | 34,480,600 | 652,000 | 7,762,100 | 558,100 |
| March, | 33,949,000 | 650,300 | 7,451,900 | 561,600 |
| April, | 32,894,700 | 652,000 | 7,389,600 | 604,000 |
| May, | 35,254,900 | 787,400 | 8,277,400 | 714,500 |
| June, | 35,478,100 | 830,600 | 9,033,300 | 758,000 |
| July, | 33,362,800 | 788,400 | 9,300,100 | 745,100 |
| August, | 33,800,400 | 621,300 | 9,564,700 | 760,300 |
| September, | 34,500,200 | 635,400 | 9,417,900 | 816,400 |
| October, | 32,381,800 | 535,800 | 8,140,300 | 710,000 |
| November, | 31,389,000 | 478,000 | 7,624,600 | 646,000 |
| December, | 34,609,000 | 474,800 | 8,145,300 | 627,400 |
| For the year, | 33,870,300 | 646,400 | 8,309,300 | 670,600 |

TABLE NO. 22. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1906.*

| City or town, | BOSTON. | | SOMERVILLE. | | MALDEN. | | CHELSEA. | | EVERETT. | | QUINCY. | | MEDFORD. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, | 601,430. | | 70,950. | | 39,040. | | 38,000. | | 30,270. | | 28,300. | | 20,080. | |
| | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | |
| MONTH. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | 94,307,000 | 158 | 6,154,700 | 88 | 1,986,300 | 51 | 3,849,800 | 102 | 2,469,900 | 83 | 2,967,300 | 105 | 1,812,400 | 91 |
| February, | 96,899,900 | 162 | 6,191,300 | 88 | 1,945,900 | 50 | 4,430,800 | 117 | 2,724,500 | 91 | 3,000,100 | 107 | 1,877,400 | 94 |
| March, | 92,238,900 | 154 | 5,825,800 | 83 | 1,896,000 | 49 | 3,993,900 | 106 | 2,520,900 | 84 | 3,065,700 | 108 | 1,793,700 | 90 |
| April, | 87,578,500 | 146 | 5,797,000 | 81 | 1,927,000 | 50 | 3,492,700 | 93 | 2,330,200 | 78 | 2,896,600 | 103 | 1,804,500 | 90 |
| May, | 89,632,300 | 149 | 6,363,900 | 90 | 2,040,900 | 52 | 3,390,260 | 89 | 2,399,100 | 80 | 3,149,800 | 112 | 2,086,300 | 104 |
| June, | 90,740,400 | 151 | 6,620,900 | 93 | 2,120,900 | 54 | 3,499,000 | 92 | 2,494,800 | 83 | 3,309,600 | 117 | 2,109,700 | 105 |
| July, | 88,845,700 | 148 | 6,523,300 | 92 | 2,162,500 | 55 | 3,527,800 | 93 | 2,409,500 | 80 | 3,095,000 | 109 | 2,056,700 | 103 |
| August, | 89,613,700 | 149 | 6,703,700 | 94 | 2,091,700 | 53 | 3,681,000 | 97 | 2,486,800 | 82 | 3,214,600 | 113 | 2,169,600 | 108 |
| September, | 89,513,400 | 149 | 6,529,100 | 92 | 2,112,100 | 54 | 3,692,600 | 97 | 2,436,600 | 80 | 3,268,700 | 115 | 2,352,200 | 117 |
| October, | 86,654,400 | 143 | 6,342,700 | 89 | 1,887,700 | 48 | 3,321,400 | 87 | 2,244,900 | 74 | 2,824,400 | 99 | 2,098,300 | 104 |
| November, | 85,592,600 | 141 | 6,037,300 | 84 | 1,899,500 | 48 | 3,154,000 | 83 | 2,123,800 | 69 | 2,726,400 | 95 | 1,945,800 | 96 |
| December, | 100,045,800 | 165 | 6,581,800 | 92 | 1,927,700 | 49 | 4,336,400 | 113 | 2,678,400 | 87 | 2,775,400 | 97 | 2,055,000 | 101 |
| For the year, | 90,951,800 | 151 | 6,301,000 | 89 | 2,000,100 | 51 | 3,694,000 | 97 | 2,441,600 | 81 | 3,021,800 | 107 | 2,014,100 | 100 |

TABLE No. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

| City or town, | Melrose. | | Revere. | | Watertown. | | Arlington. | | Milton. | | Winthrop. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, | 14,650. | | 13,390. | | 11,550. | | 9,940. | | 7,120. | | 7,240. | |
| | Gallons. | | Gallons. | | Gallons. | | Gallons. | | Gallons. | | Gallons. | |
| Month. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | 1,623,100 | 112 | 882,800 | 67 | 685,300 | 60 | 687,500 | 70 | 255,500 | 36 | 700,500 | 98 |
| February, | 1,616,000 | 111 | 981,700 | 74 | 674,400 | 59 | 739,100 | 75 | 251,000 | 35 | 745,100 | 104 |
| March, | 1,582,400 | 109 | 962,600 | 73 | 686,800 | 60 | 711,100 | 72 | 274,700 | 39 | 701,500 | 98 |
| April, | 1,621,000 | 111 | 875,400 | 66 | 730,800 | 64 | 713,100 | 72 | 295,500 | 42 | 690,900 | 96 |
| May, | 1,645,800 | 113 | 1,059,100 | 80 | 840,000 | 73 | 871,700 | 88 | 438,100 | 62 | 765,600 | 106 |
| June, | 1,545,800 | 106 | 1,294,600 | 97 | 851,800 | 74 | 897,400 | 90 | 451,400 | 64 | 917,400 | 127 |
| July, | 1,589,900 | 108 | 1,324,100 | 99 | 811,300 | 70 | 829,500 | 83 | 398,300 | 56 | 979,200 | 135 |
| August, | 1,608,200 | 110 | 1,404,200 | 104 | 797,700 | 69 | 866,200 | 87 | 434,100 | 61 | 1,057,800 | 145 |
| September, | 1,657,900 | 113 | 1,250,900 | 93 | 827,600 | 71 | 940,400 | 94 | 435,500 | 61 | 953,000 | 131 |
| October, | 1,566,000 | 107 | 984,600 | 73 | 827,500 | 71 | 824,000 | 82 | 335,700 | 47 | 784,200 | 107 |
| November, | 1,484,600 | 101 | 928,400 | 68 | 806,000 | 69 | 757,800 | 76 | 311,500 | 43 | 723,100 | 98 |
| December, | 1,555,300 | 106 | 1,158,900 | 85 | 710,700 | 61 | 768,700 | 76 | 315,400 | 44 | 811,700 | 110 |
| For the year, | 1,591,300 | 109 | 1,093,200 | 82 | 771,300 | 67 | 800,800 | 81 | 350,300 | 49 | 819,800 | 113 |

TABLE NO. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

| City or town, | Stoneham. | | Belmont. | | Lexington. | | Nahant. | | Swampscott. | | Metropolitan District. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, | 6,350. | | 4,410. | | 4,230. | | 1,850. | | 6,240. | | 915,040. | |
| | Gallons. | | Gallons. | | Gallons. | | Gallons. | | Gallons. | | Gallons. | |
| Month. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | 396,500 | 62 | 166,500 | 38 | 235,800 | 57 | 57,300 | 62 | 459,100 | 87 | 119,697,300 | 132 |
| February, | 398,500 | 63 | 168,200 | 38 | 250,200 | 60 | 62,800 | 68 | 394,800 | 75 | 123,351,700 | 136 |
| March, | 375,900 | 59 | 199,600 | 45 | 260,600 | 62 | 57,400 | 62 | 360,400 | 68 | 117,477,900 | 129 |
| April, | 391,100 | 62 | 235,900 | 54 | 310,300 | 74 | 63,200 | 68 | 375,300 | 71 | 112,039,000 | 123 |
| May, | 421,900 | 67 | 332,500 | 76 | 408,200 | 97 | 132,800 | 69 | 466,500 | 74 | 116,444,700 | 128 |
| June, | 434,400 | 69 | 337,500 | 77 | 423,900 | 101 | 217,200 | 74 | 567,300 | 78 | 118,834,000 | 130 |
| July, | 438,500 | 69 | 312,400 | 71 | 405,700 | 96 | 232,100 | 68 | 679,000 | 87 | 116,620,500 | 127 |
| August, | 483,500 | 76 | 337,000 | 76 | 413,800 | 98 | 273,000 | 80 | 752,700 | 96 | 118,389,300 | 129 |
| September, | 535,800 | 84 | 409,100 | 92 | 398,700 | 92 | 241,200 | 82 | 646,700 | 88 | 118,196,500 | 129 |
| October, | 498,500 | 78 | 288,000 | 65 | 335,400 | 79 | 93,200 | 48 | 430,400 | 68 | 112,841,300 | 123 |
| November, | 459,000 | 72 | 231,900 | 52 | 291,500 | 68 | 69,000 | 74 | 410,600 | 76 | 109,952,800 | 119 |
| December, | 458,600 | 71 | 249,500 | 56 | 285,100 | 66 | 78,700 | 85 | 357,900 | 66 | 127,156,000 | 138 |
| For the year, | 441,200 | 69 | 272,900 | 62 | 335,000 | 79 | 131,900 | 71 | 492,500 | 79 | 117,524,600 | 128 |

TABLE No. 23. — *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1906, the Town of Swampscott and a Small Section of the Town of Saugus, from 1893 to 1906.*

[Gallons per Day.]

| MONTH. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|---|---|
| January, | 75,209,000 | 67,506,000 | 68,925,000 | 82,946,000 | 85,866,000 | 83,880,000 | 96,443,000 |
| February, | 71,900,000 | 68,944,000 | 80,375,000 | 87,021,000 | 88,967,000 | 87,475,000 | 108,454,000 |
| March, | 67,638,000 | 62,710,000 | 69,543,000 | 86,111,000 | 82,751,000 | 85,468,000 | 90,200,000 |
| April, | 62,309,000 | 57,715,000 | 62,909,000 | 77,529,000 | 79,914,000 | 76,574,000 | 86,491,000 |
| May, | 61,025,000 | 60,676,000 | 65,194,000 | 78,402,000 | 76,772,000 | 76,677,000 | 89,448,000 |
| June, | 63,374,000 | 68,329,000 | 69,905,000 | 77,639,000 | 77,952,000 | 83,463,000 | 97,691,000 |
| July, | 69,343,000 | 73,642,000 | 69,667,000 | 80,000,000 | 85,525,000 | 88,228,000 | 96,821,000 |
| August, | 66,983,000 | 67,995,000 | 72,233,000 | 78,537,000 | 84,103,000 | 87,558,000 | 92,072,000 |
| September, | 64,654,000 | 67,187,000 | 73,724,000 | 74,160,000 | 84,296,000 | 88,296,000 | 91,478,000 |
| October, | 63,770,000 | 62,735,000 | 67,028,000 | 71,762,000 | 79,551,000 | 81,770,000 | 89,580,000 |
| November, | 61,204,000 | 62,231,000 | 64,881,000 | 71,983,000 | 72,762,000 | 78,177,000 | 86,719,000 |
| December, | 66,700,000 | 65,108,000 | 70,443,000 | 79,449,000 | 76,594,000 | 86,355,000 | 85,840,000 |
| Average, | 66,165,000 | 65,382,000 | 69,499,000 | 78,360,000 | 80,793,000 | 83,651,000 | 92,111,000 |
| Population, | 723,153 | 743,354 | 763,557 | 786,385 | 809,213 | 832,042 | 854,870 |
| Per capita, | 91.5 | 88.0 | 91.0 | 99.7 | 99.8 | 100.5 | 107.8 |

| MONTH. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. |
|---|---|---|---|---|---|---|---|
| January, | 100,055,000 | 111,275,000 | 118,485,000 | 125,176,000 | 137,771,000 | 130,878,000 | 126,093,000 |
| February, | 98,945,000 | 117,497,000 | 117,268,000 | 123,728,000 | 143,222,000 | 140,595,000 | 130,766,000 |
| March, | 97,758,000 | 105,509,000 | 108,461,000 | 111,977,000 | 123,334,000 | 120,879,000 | 123,570,000 |
| April, | 89,497,000 | 93,317,000 | 103,153,000 | 107,179,000 | 108,688,000 | 111,898,000 | 118,428,000 |
| May, | 87,780,000 | 95,567,000 | 106,692,000 | 111,589,000 | 111,715,000 | 115,804,000 | 122,404,000 |
| June, | 98,581,000 | 108,420,000 | 110,002,000 | 105,590,000 | 111,209,000 | 117,441,000 | 121,882,000 |
| July, | 107,786,000 | 106,905,000 | 108,840,000 | 107,562,000 | 113,584,000 | 124,769,000 | 118,726,000 |
| August, | 102,717,000 | 102,815,000 | 107,045,000 | 103,570,000 | 112,836,000 | 121,158,000 | 120,591,000 |
| September, | 103,612,000 | 102,103,000 | 107,752,000 | 106,772,000 | 114,188,000 | 120,103,000 | 121,685,000 |
| October, | 98,358,000 | 103,389,000 | 106,560,000 | 103,692,000 | 108,290,000 | 118,301,000 | 116,561,000 |
| November, | 93,648,000 | 101,324,000 | 105,175,000 | 103,477,000 | 108,054,000 | 116,693,000 | 118,746,000 |
| December, | 97,844,000 | 113,268,000 | 125,434,000 | 114,721,000 | 125,119,000 | 122,696,000 | 130,995,000 |
| Average, | 98,069,000 | 104,645,000 | 110,345,000 | 110,277,000 | 118,114,000 | 121,671,000 | 122,085,000 |
| Population, | 877,698 | 892,740 | 907,780 | 922,820 | 937,860 | 953,556 | 965,990 |
| Per capita, | 111.7 | 117.2 | 121.6 | 119.5 | 125.9 | 127.6 | 126.4 |

This table includes the water consumed in the cities and towns enumerated in Table No. 19, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1904 have been revised since the census of 1905 became available, and consequently differ from those published in a corresponding table in the preceding annual reports.

**Table No. 24. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.***

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | Color. | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Albuminoid. Total. | Albuminoid. Dissolved. | Albuminoid. Suspended. | | Nitrates. | Nitrites. | | |
| | 1906. | | | | | | | | | | | | | | | | |
| 59009 | Jan. 23 | V. slight. | Slight. | 23 | None. | Faintly vegetable. | 3.30 | 1.25 | .0020 | .0138 | .0116 | .0022 | .25 | .0010 | .0001 | .39 | 0.8 |
| 59200 | Feb. 13 | V. slight. | V. slight. | 23 | V. faintly vegetable. | Faintly vegetable. | 3.20 | 1.15 | .0024 | .0116 | .0110 | .0006 | .28 | .0010 | .0000 | .34 | 0.6 |
| 59550 | March 6 | V. slight. | V. slight. | 25 | Faintly vegetable. | Faintly vegetable. | 3.00 | 1.40 | .0028 | .0134 | .0120 | .0014 | .27 | .0030 | .0000 | .37 | 1.0 |
| 60091 | April 3 | V. slight. | Slight. | 23 | Faintly vegetable and unpleasant. | Distinctly vegetable and unpleasant. | 2.35 | 0.80 | .0010 | .0130 | .0108 | .0022 | .26 | .0030 | .0001 | .37 | 0.5 |
| 60470 | May 8 | V. slight. | Slight. | 23 | Faintly vegetable. | Faintly vegetable. | 2.45 | 1.15 | .0020 | .0162 | .0110 | .0052 | .25 | .0020 | .0001 | .31 | 0.6 |
| 60875 | June 5 | V. slight. | Cons. | 25 | Distinctly unpleasant and musty. | Distinctly unpleasant and musty. | 3.10 | 1.05 | .0068 | .0204 | .0118 | .0086 | .24 | .0020 | .0002 | .35 | 0.6 |
| 61376 | July 2 | V. slight. | Slight. | 24 | Faintly vegetable. | Distinctly vegetable. | 3.20 | 1.20 | .0030 | .0182 | .0158 | .0024 | .21 | .0010 | .0002 | .43 | 0.6 |
| 61812 | July 31 | V. slight. | Slight. | 18 | None. | V. faintly vegetable. | 3.65 | 1.60 | .0014 | .0152 | .0122 | .0030 | .21 | .0010 | .0000 | .40 | 0.5 |
| 62537 | Sept. 4 | V. slight. | Slight. | 21 | Faintly vegetable and sweetish. | Distinctly vegetable and sweetish. | 2.50 | 1.05 | .0016 | .0198 | .0162 | .0036 | .20 | .0010 | .0000 | .32 | 0.5 |
| 63074 | Oct. 2 | V. slight. | Slight. | 18 | Faintly vegetable. | Distinctly vegetable. | 3.00 | 1.00 | .0028 | .0144 | .0130 | .0014 | .22 | .0000 | .0001 | .28 | 0.8 |
| 63622 | Nov. 6 | V. slight. | V. slight. | 20 | Faintly vegetable. | Faintly vegetable. | 3.00 | 1.25 | .0018 | .0126 | .0110 | .0016 | .23 | .0020 | .0001 | .30 | 1.0 |
| 63973 | Dec. 4 | V. slight. | V. slight. | 17 | Faintly vegetable. | Distinctly vegetable. | 2.70 | 1.10 | .0016 | .0100 | .0080 | .0020 | .22 | .0010 | .0001 | .27 | 1.0 |
| Av. | .......... | .......... | .......... | 22 | .......... | .......... | 2.95 | 1.17 | .0024 | .0149 | .0120 | .0029 | .24 | .0015 | .0001 | .34 | 0.7 |

TABLE NO. 25. — *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | Color. | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Albuminoid. | | | | | | | |
| | | Turbidity. | Sediment. | Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | | |
| | 1906. | | | | | | | | | | | | | | | | |
| 59160 | Feb. 12 | Slight. | Slight. | 28 | Faintly unpleasant. | Distinctly unpleasant, fishy. | 3.75 | 1.35 | .0016 | .0186 | .0126 | .0060 | .30 | .0030 | .0000 | .40 | 1.0 |
| 59516 | March 6 | V. slight. | Slight. | 26 | Faintly unpleasant. | Distinctly unpleasant, fishy. | 3.45 | 1.30 | .0028 | .0154 | .0124 | .0030 | .28 | .0050 | .0001 | .36 | 0.8 |
| 60046 | April 2 | V. slight. | Slight. | 23 | Faintly vegetable. | Distinctly vegetable. | 3.60 | 1.20 | .0030 | .0160 | .0132 | .0028 | .28 | .0080 | .0001 | .28 | 1.1 |
| 60464 | May 7 | Slight. | Cons. | 23 | Faintly unpleasant. | Distinctly unpleasant. | 3.65 | 1.60 | .0032 | .0196 | .0138 | .0058 | .30 | .0090 | .0002 | .37 | 1.1 |
| 60819 | June 4 | V. slight. | Slight. | 23 | Faintly vegetable. | Distinctly vegetable. | 3.45 | 1.20 | .0058 | .0174 | .0114 | .0060 | .29 | .0040 | .0001 | .30 | 1.1 |
| 61366 | July 2 | V. slight. | Slight. | 25 | Faintly vegetable and distinctly sweetish. | Faintly vegetable and distinctly sweetish. | 3.40 | 1.20 | .0044 | .0192 | .0168 | .0024 | .28 | .0020 | .0002 | .39 | 1.1 |
| 61771 | July 30 | V. slight. | V. slight. | 22 | Faintly unpleasant and musty. | Faintly unpleasant and musty. | 3.30 | 1.05 | .0032 | .0172 | .0142 | .0030 | .27 | .0010 | .0000 | .36 | 1.0 |
| 62541 | Sept. 4 | V. slight. | Slight. | 17 | Faintly vegetable. | Distinctly vegetable. | 2.95 | 1.40 | .0032 | .0136 | .0120 | .0016 | .23 | .0000 | .0001 | .30 | 1.0 |
| 63046 | Oct. 2 | V. slight. | Slight. | 13 | Faintly vegetable. | Faintly vegetable. | 2.75 | 1.20 | .0044 | .0146 | .0116 | .0030 | .24 | .0010 | .0000 | .31 | 0.6 |
| 63574 | Nov. 5 | V. slight. | V. slight. | 16 | Faintly vegetable. | Faintly vegetable. | 3.10 | 1.25 | .0032 | .0158 | .0140 | .0018 | .28 | .0010 | .0000 | .34 | 1.0 |
| 63945 | Dec. 3 | V. slight. | V. slight. | 14 | Faintly vegetable. | Distinctly vegetable. | 2.95 | 1.20 | .0026 | .0144 | .0106 | .0038 | .26 | .0020 | .0000 | .28 | 1.3 |
| Av. | .......... | .......... | .......... | 21 | .......... | .......... | 3.30 | 1.27 | .0034 | .0165 | .0130 | .0036 | .27 | .0033 | .0001 | .34 | 1.0 |

TABLE NO. 26. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | Color. | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Albuminoid. Total. | Albuminoid. Dissolved. | Albuminoid. Suspended. | | Nitrates. | Nitrites. | | |
| | 1906. | | | | | | | | | | | | | | | | |
| 59150 | Feb. 12 | V. slight. | V. slight. | 12 | V. faintly vegetable and unpleasant. | Faintly vegetable and unpleasant. | 3.35 | 1.10 | .0016 | .0160 | .0134 | .0026 | .34 | .0020 | .0001 | .32 | 1.1 |
| 60045 | April 2 | V. slight. | Slight. | 12 | Faint cucumber odor. | Distinct cucumber odor. | 3.10 | 1.35 | .0008 | .0176 | .0146 | .0030 | .30 | .0020 | .0001 | .18 | 1.3 |
| 60788 | June 1 | V. slight. | V. slight. | 14 | Faintly vegetable. | Distinctly vegetable. | 3.65 | 1.55 | .0018 | .0164 | .0140 | .0024 | .30 | .0020 | .0000 | .29 | 1.0 |
| 61760 | July 30 | V. slight. | Slight. | 12 | Faintly unpleasant, anabæna. | Distinctly unpleasant, anabæna. | 3.35 | 1.55 | .0024 | .0162 | .0138 | .0024 | .36 | .0010 | .0000 | .27 | 1.6 |
| 63068 | Oct. 2 | V. slight. | Slight. | 10 | Distinctly vegetable. | Distinctly vegetable. | 3.55 | 1.35 | .0022 | .0154 | .0124 | .0030 | .32 | .0000 | .0000 | .25 | 1.1 |
| 63923 | Dec. 3 | V. slight. | Slight. | 10 | V. faintly vegetable. | Faintly vegetable. | 3.55 | 1.10 | .0022 | .0156 | .0150 | .0006 | .33 | .0020 | .0000 | .27 | 1.4 |
| Av. | .......... | .......... | .......... | 12 | .......... | .......... | 3.43 | 1.33 | .0018 | .0162 | .0139 | .0023 | .32 | .0015 | .0000 | .26 | 1.3 |

TABLE NO. 27. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | Color. | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Albuminoid. Total. | Albuminoid. Dissolved. | Albuminoid. Suspended. | | Nitrates. | Nitrites. | | |
| | **1906.** | | | | | | | | | | | | | | | | |
| 58980 | Jan. 22 | V. slight. | Cons. | 25 | Distinctly unpleasant. | Distinctly unpleasant. | 4.50 | 1.75 | .0034 | .0230 | .0162 | .0068 | .50 | .0010 | .0001 | .42 | 1.8 |
| 59172 | Feb. 12 | V. slight. | Slight. | 24 | Faintly unpleasant. | Faintly unpleasant. | 4.85 | 1.65 | .0020 | .0198 | .0164 | .0034 | .50 | .0000 | .0000 | .43 | 1.8 |
| 59496 | March 5 | Slight. | Cons. | 24 | Distinctly unpleasant and decidedly musty. | Distinctly unpleasant and decidedly musty. | 4.55 | 1.75 | .0022 | .0196 | .0162 | .0034 | .52 | .0010 | .0000 | .42 | 1.8 |
| 60063 | April 2 | V. slight. | Slight. | 27 | Faintly unpleasant. | Distinctly unpleasant. | 5.15 | 1.80 | .0018 | .0196 | .0152 | .0044 | .47 | .0030 | .0001 | .40 | 1.6 |
| 60461 | May 7 | Slight. | Cons. | 27 | Distinctly unpleasant, decaying organisms. | Distinctly unpleasant, decaying organisms. | 5.15 | 1.85 | .0022 | .0200 | .0170 | .0030 | .51 | .0040 | .0001 | .48 | 1.7 |
| 60800 | June 4 | V. slight. | Slight. | 28 | Faintly vegetable. | Faintly vegetable. | 5.20 | 1.85 | .0060 | .0192 | .0170 | .0022 | .49 | .0040 | .0002 | .46 | 1.8 |
| 61428 | July 9 | Slight. | Cons. | 27 | Distinctly vegetable. | Distinctly vegetable. | 6.55 | 1.75 | .0026 | .0224 | .0180 | .0044 | .51 | .0000 | .0000 | .54 | 2.0 |
| 61766 | July 30 | Slight. | Cons. | 29 | Faintly vegetable, anabæna. | Distinctly vegetable, anabæna. | 4.70 | 2.00 | .0022 | .0254 | .0210 | .0044 | .49 | .0000 | .0000 | .49 | 1.1 |
| 62533 | Sept. 4 | Slight. | Slight. | 25 | Faintly vegetable. | Distinctly vegetable. | 5.00 | 1.90 | .0064 | .0296 | .0234 | .0062 | .53 | .0000 | .0000 | .52 | 2.0 |
| 63027 | Oct. 2 | V. slight. | Slight. | 24 | Distinctly unpleasant and vegetable. | Distinctly unpleasant and vegetable. | 5.55 | 2.05 | .0008 | .0218 | .0202 | .0016 | .50 | .0010 | .0000 | .49 | 2.0 |
| 63575 | Nov. 5 | Slight. | Slight. | 32 | Faintly vegetable. | Distinctly vegetable. | 6.30 | 3.60 | .0070 | .0264 | .0224 | .0040 | .56 | .0010 | .0001 | .48 | 2.2 |
| 63933 | Dec. 3 | Slight. | Cons. | 26 | Faintly cucumber, synura. | Decidedly cucumber, synura. | 4.70 | 1.80 | .0060 | .0224 | .0162 | .0062 | .51 | .0020 | .0004 | .42 | 2.2 |
| Av. | .......... | .......... | .......... | 27 | .......................... | .......................... | 5.18 | 1.98 | .0033 | .0224 | .0183 | .0042 | .51 | .0014 | .0001 | .46 | 1.8 |

TABLE NO. 28. — *Chemical Examinations of Water from a Faucet at the State House, Boston.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. Turbidity. | Appearance. Sediment. | Appearance. Color. Platinum Standard. | Odor. Cold. | Odor. Hot. | Residue on Evaporation. Total. | Residue on Evaporation. Loss on Ignition. | Ammonia. Free. | Ammonia. Albuminoid. Total. | Ammonia. Albuminoid. Dissolved. | Ammonia. Albuminoid. Suspended. | Chlorine. | Nitrogen as Nitrates. | Nitrogen as Nitrites. | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | | | | | | | | | | | | | | | | |
| 58965 | Jan. 22 | V. slight. | Slight. | 20 | Faintly unpleasant and distinctly fishy. | Distinctly unpleasant and fishy. | 3.35 | 1.35 | .0020 | .0130 | .0116 | .0014 | .30 | .0030 | .0001 | .33 | 1.1 |
| 59137 | Feb. 12 | V. slight. | V. slight. | 22 | Faintly unpleasant and cucumber, synura. | Faintly unpleasant and cucumber, synura. | 3.40 | 1.40 | .0022 | .0148 | .0122 | .0026 | .32 | .0070 | .0000 | .32 | 1.1 |
| 59494 | March 5 | Slight. | Slight. | 23 | Distinctly vegetable. | Distinctly vegetable. | 3.40 | 1.30 | .0018 | .0124 | .0112 | .0012 | .32 | .0070 | .0001 | .31 | 1.1 |
| 60051 | April 3 | V. slight. | Slight. | 25 | Faintly unpleasant, fishy. | Distinctly unpleasant, fishy. | 3.30 | 1.45 | .0022 | .0136 | .0118 | .0018 | .26 | .0110 | .0001 | .31 | 1.0 |
| 60456 | May 7 | V. slight. | Slight. | 28 | Faintly vegetable. | Distinctly vegetable. | 4.95 | 1.55 | .0020 | .0154 | .0122 | .0032 | .34 | .0090 | .0001 | .44 | 1.3 |
| 60774 | June 4 | Decided. | Cons. | 25 | Distinctly vegetable. | Decidedly vegetable. | 4.15 | 1.40 | .0028 | .0224 | .0156 | .0068 | .38 | .0090 | .0000 | .36 | 1.6 |
| 61378 | July 3 | V. slight. | Slight. | 21 | Faintly unpleasant, fishy. | Distinctly unpleasant, dinobryon. | 4.10 | 1.50 | .0014 | .0170 | .0150 | .0020 | .35 | .0010 | .0000 | .38 | 1.6 |
| 61755 | July 30 | V. slight. | V. slight. | 25 | V. faintly vegetable. | Faintly vegetable. | 4.00 | 1.25 | .0018 | .0154 | .0146 | .0008 | .38 | .0030 | .0000 | .36 | 1.3 |
| 62526 | Sept. 4 | Slight. | Slight. | 23 | Faintly vegetable. | Faintly vegetable. | 4.55 | 1.75 | .0010 | .0180 | .0148 | .0032 | .35 | .0030 | .0001 | .34 | 1.7 |
| 63025 | Oct. 1 | V. slight. | V. slight. | 24 | Faintly vegetable. | Distinctly vegetable. | 3.70 | 1.10 | .0006 | .0174 | .0150 | .0024 | .38 | .0070 | .0000 | .38 | 1.6 |
| 63577 | Nov. 5 | None. | V. slight. | 27 | V. faintly vegetable. | Faintly vegetable. | 3.75 | 1.00 | .0018 | .0146 | .0134 | .0012 | .36 | .0020 | .0001 | .45 | 1.4 |
| 63921 | Dec. 3 | V. slight. | Slight. | 19 | Distinctly unpleasant, fishy. | Decidedly unpleasant, fishy. | 3.65 | 1.60 | .0018 | .0164 | .0132 | .0032 | .31 | .0030 | .0000 | .28 | 1.1 |
| Av. | .......... | .......... | .......... | 24 | .......... | .......... | 3.86 | 1.39 | .0018 | .0159 | .0134 | .0025 | .34 | .0054 | .0001 | .36 | 1.3 |

TABLE NO. 29.—*Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1906.*

[Parts per 100,000.]

| Locality. | Samples Collected. | Color. | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Albuminoid. | | | | | | | |
| | | Platinum Standard. | Total. | Loss on Ignition. | Free. | Total. | Dis-solved. | Sus-pended. | | Nitrates. | Nitrites. | | |
| Quinepoxet River, Holden, | Bi-monthly, | 34 | 3.64 | 1.55 | .0022 | .0179 | .0147 | .0032 | .33 | .0060 | .0001 | .55 | 0.7 |
| Stillwater River, Sterling, | Bi-monthly, | 39 | 3.61 | 1.43 | .0018 | .0140 | .0123 | .0017 | .23 | .0032 | .0001 | .45 | 0.7 |
| Wachusett Reservoir, West Boylston, | Monthly, | 36 | 3.35 | 1.33 | .0028 | .0161 | .0139 | .0022 | .24 | .0046 | .0001 | .45 | 0.7 |
| Wachusett Reservoir, Clinton, surface, | Monthly, | 22 | 2.95 | 1.17 | .0024 | .0149 | .0120 | .0029 | .24 | .0015 | .0001 | .34 | 0.7 |
| Wachusett Reservoir, Clinton, El. 288, | Monthly, | 22 | 3.02 | 1.20 | .0031 | .0136 | .0116 | .0020 | .24 | .0023 | .0001 | .34 | 0.7 |
| Marlborough (Walker's Brook), | Bi-monthly, | 52 | 16.98 | 4.96 | .2752 | .0444 | .0339 | .0105 | 2.14 | .1574 | .0049 | .80 | 5.5 |
| Marlborough Brook filter-beds, effluent, | Bi-monthly, | 8 | 13.97 | - | .0240 | .0098 | - | - | 1.79 | .2308 | .0006 | .17 | 4.4 |
| Wachusett Aqueduct, Southborough, | Monthly, | 28 | 3.26 | 1.33 | .0036 | .0146 | .0125 | .0021 | .24 | .0034 | .0002 | .39 | 0.9 |
| Sudbury Reservoir, surface, | Monthly, | 21 | 3.30 | 1.27 | .0034 | .0165 | .0130 | .0036 | .27 | .0033 | .0001 | .34 | 1.0 |
| Framingham Reservoir, No. 3, near dam, | Monthly, | 21 | 3.47 | 1.39 | .0024 | .0158 | .0131 | .0027 | .28 | .0035 | .0001 | .33 | 1.1 |
| Hopkinton Reservoir, inlet, | Bi-monthly, | 138 | 6.00 | 3.00 | .0029 | .0307 | .0290 | .0017 | .52 | .0018 | .0001 | 1.43 | 1.4 |
| Hopkinton Reservoir, surface, | Bi-monthly, | 64 | 4.03 | 1.86 | .0034 | .0205 | .0186 | .0019 | .35 | .0027 | .0001 | .70 | 0.9 |

Table No. 29. — *Averages of Examinations of Water, etc.* — Concluded.

[Parts per 100,000.]

| Locality. | Samples Collected. | Color. | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Albuminoid. | | | | | | | |
| | | Platinum Standard. | Total. | Loss on Ignition. | Free. | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | | |
| Ashland Reservoir, inlet, | Bi-monthly, | 110 | 5.43 | 2.54 | .0028 | .0270 | .0244 | .0026 | .34 | .0027 | .0001 | 1.14 | 1.2 |
| Ashland Reservoir, surface, | Bi-monthly, | 62 | 3.65 | 1.75 | .0025 | .0213 | .0185 | .0028 | .29 | .0015 | .0001 | .74 | 0.8 |
| Framingham Reservoir No. 2, inlet, | Bi-monthly, | 81 | 4.38 | 2.01 | .0063 | .0223 | .0200 | .0022 | .33 | .0042 | .0001 | .83 | 1.0 |
| Framingham Reservoir No. 2, near dam, | Bi-monthly, | 75 | 4.28 | 1.83 | .0063 | .0226 | .0199 | .0026 | .33 | .0023 | .0001 | .82 | 0.9 |
| Lake Cochituate, | Monthly, | 27 | 5.18 | 1.98 | .0063 | .0224 | .0183 | .0042 | .51 | .0014 | .0001 | .46 | 1.8 |
| Terminal chamber, Sudbury Aqueduct, | Bi-monthly, | 24 | 3.43 | 1.33 | .0024 | .0157 | .0128 | .0028 | .29 | .0040 | .0001 | .35 | 1.1 |
| Spot Pond, | Bi-monthly, | 12 | 3.43 | 1.33 | .0018 | .0162 | .0139 | .0023 | .32 | .0015 | .0000 | .26 | 1.3 |
| Tap in Revere, | Bi-monthly, | 12 | 3.75 | 1.24 | .0019 | .0133 | .0122 | .0011 | .33 | .0012 | .0001 | .27 | 1.2 |
| Tap at State House, | Monthly, | 24 | 3.86 | 1.39 | .0018 | .0159 | .0134 | .0025 | .34 | .0054 | .0001 | .36 | 1.3 |
| Tap in Quincy, | Bi-monthly, | 20 | 3.91 | 1.58 | .0015 | .0136 | .0124 | .0012 | .35 | .0072 | .0001 | .34 | 1.3 |

TABLE No. 30. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1906.*

[Parts per 100,000.]

| YEAR. | COLOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | | | Chlorine. | NITROGEN AS | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nessler Standard. | Platinum Standard. | Total. | Loss on Ignition. | Free. | ALBUMINOID. Total. | Dis-solved. | Sus-pended. | | Nitrates. | Nitrites. | | |
| 1892, . . | .37 | 37 | 4.70 | 1.67 | .0007 | .0168 | .0138 | .0030 | .41 | .0210 | .0001 | - | 1.9 |
| 1893, . . | .61 | 53 | 4.54 | 1.84 | .0010 | .0174 | .0147 | .0027 | .38 | .0143 | .0001 | .60 | 1.8 |
| 1894, . . | .69 | 58 | 4.64 | 1.83 | .0006 | .0169 | .0150 | .0019 | .41 | .0106 | .0001 | .63 | 1.7 |
| 1895, . . | .72 | 59 | 4.90 | 2.02 | .0006 | .0197 | .0175 | .0022 | .40 | .0171 | .0001 | .69 | 0.7 |
| 1896, . . | .49 | 45 | 4.29 | 1.67 | .0005 | .0165 | .0142 | .0023 | .37 | .0155 | .0001 | .56 | 1.4 |
| 1897, . . | .65 | 55 | 4.82 | 1.84 | .0009 | .0193 | .0177 | .0016 | .40 | .0137 | .0001 | .64 | 1.6 |
| 1898, . . | .41 | 40 | 4.19 | 1.60 | .0008 | .0152 | .0136 | .0016 | .29 | .0097 | .0001 | .44 | 1.4 |
| 1899, . . | .23 | 28 | 3.70 | 1.30 | .0006 | .0136 | .0122 | .0014 | .24 | .0137 | .0001 | .35 | 1.1 |
| 1900, . . | .24 | 29 | 3.80 | 1.20 | .0012 | .0157 | .0139 | .0018 | .25 | .0076 | .0001 | .38 | 1.3 |
| 1901, . . | .24 | 29 | 4.43 | 1.64 | .0013 | .0158 | .0142 | .0016 | .30 | .0173 | .0001 | .42 | 1.7 |
| 1902, . . | .26 | 30 | 3.93 | 1.56 | .0016 | .0139 | .0119 | .0020 | .29 | .0092 | .0000 | .40 | 1.3 |
| 1903, . . | .25 | 29 | 3.98 | 1.50 | .0013 | .0125 | .0110 | .0015 | .30 | .0142 | .0001 | .39 | 1.5 |
| 1904, . . | - | 23 | 3.93 | 1.59 | .0023 | .0139 | .0121 | .0018 | .34 | .0110 | .0001 | .37 | 1.5 |
| 1905, . . | - | 24 | 3.86 | 1.59 | .0020 | .0145 | .0124 | .0021 | .35 | .0083 | .0001 | .35 | 1.4 |
| 1906, . . | - | 24 | 3.86 | 1.39 | .0018 | .0159 | .0134 | .0025 | .34 | .0054 | .0001 | .36 | 1.3 |

*Note relating to Chemical Examinations of Water, Tables Nos. 24–30.*

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The more important samples are collected and examined monthly; those of less significance, at intervals of two or three months.

TABLE No. 31. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1906. (Means of Weekly Determinations.)*

[Platinum Standard.]

| MONTH. | WACHUSETT RESERVOIR. | | | | | SUDBURY RESERVOIR. | | | | FRAMINGHAM RESERVOIR No. 3. | SPOT POND. | FELLS RESERVOIR. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Mid-depth. | Bottom. | Worcester Street Bridge. | Aqueduct Head House. | Surface. | Mid-depth. | Bottom. | End of Open Channel. | Mid-depth. | Mid-depth. | Effluent Gate-house. |
| January, | 23 | 26 | 26 | 43 | 24 | 23 | 23 | 24 | 38 | 23 | 18 | 18 |
| February, | 28 | 28 | 28 | 40 | 28 | 26 | 26 | 27 | 32 | 27 | 18 | 18 |
| March, | 28 | 28 | 28 | 35 | 28 | 26 | 26 | 26 | 54 | 26 | 18 | 18 |
| April, | 26 | 26 | 26 | 41 | 26 | 26 | 26 | 26 | 36 | 26 | 15 | 15 |
| May, | 26 | 26 | 26 | 66 | 25 | 26 | 26 | 27 | 43 | 28 | 16 | 17 |
| June, | 28 | 26 | 26 | 69 | 30 | 27 | 26 | 26 | 35 | 28 | 17 | 16 |
| July, | 27 | 26 | 25 | 50 | 26 | 24 | 24 | 24 | 29 | 24 | 15 | 15 |
| August, | 26 | 26 | 26 | 44 | 26 | 23 | 23 | 24 | 27 | 23 | 16 | 16 |
| September, | 23 | 23 | 23 | 33 | 23 | 20 | 20 | 20 | 24 | 20 | 15 | 15 |
| October, | 20 | 20 | 21 | 27 | 20 | 19 | 18 | 18 | 22 | 19 | 18 | 16 |
| November, | 19 | 19 | 19 | 41 | 19 | 18 | 18 | 18 | 26 | 19 | 17 | 17 |
| December, | 18 | 18 | 18 | 42 | 18 | 18 | 18 | 18 | 25 | 18 | 16 | 15 |
| Mean, | 24 | 24 | 24 | 44 | 24 | 23 | 23 | 23 | 33 | 23 | 17 | 17 |

TABLE No. 31 — *Concluded.*

[Platinum Standard.]

| MONTH. | LAKE COCHITUATE. | | | | CHESTNUT HILL RESERVOIR. | | | NORTHERN SERVICE. | | SOUTHERN SERVICE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Mid-depth. | Bottom. | Influent Streams.[1] | Inlet (Sudbury Aqueduct). | Inlet (Cochituate Aqueduct). | Effluent Gate-house No. 2. | Tap at Glenwood Yard, Medford (Low Service). | Tap at Fire Station, Hancock Street, Everett (High Service). | Tap at 244 Boylston Street, Boston (Low Service). | Tap at 1 Ashburton Place, Boston (High Service). |
| January, | 28 | 29 | 29 | 58 | 23 | 23 | 25 | 26 | 19 | 24 | 25 |
| February, | 29 | 31 | 32 | 55 | 27 | - | 25 | 24 | 19 | 26 | 26 |
| March, | 29 | 30 | 30 | 60 | 26 | - | 25 | 24 | 19 | 25 | 25 |
| April, | 29 | 29 | 30 | 73 | 24 | 27 | 24 | 23 | 16 | 24 | 24 |
| May, | 29 | 29 | 35 | 111 | 40 | 29 | 33 | 32 | 22 | 32 | 33 |
| June, | 29 | 29 | 47 | 148 | 30 | 29 | 29 | 27 | 18 | 29 | 28 |
| July, | 31 | 30 | 91 | 98 | 27 | 31 | 25 | 23 | 15 | 25 | 26 |
| August, | 30 | 29 | 72 | 57 | 28 | 29 | 27 | 25 | 16 | 27 | 28 |
| September, | 28 | 28 | 182 | 46 | 25 | 27 | 24 | 24 | 17 | 25 | 27 |
| October, | 24 | 26 | 160 | 54 | 32 | 24 | 30 | 28 | 16 | 26 | 30 |
| November, | 28 | 28 | 71 | 57 | 20 | 27 | 23 | 23 | 18 | 22 | 23 |
| December, | 26 | 26 | 26 | 54 | 18 | 25 | 18 | 18 | 15 | 18 | 19 |
| Mean, | 28 | 29 | 67 | 73 | 27 | - | 26 | 25 | 18 | 25 | 26 |

[1] The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

**Table No. 32. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1906. (Means of Weekly Determinations.)***

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

| Month. | Wachusett Reservoir. | | | Sudbury Reservoir (Depth at Place of Observation 54.5 Feet). | | | | Framingham Reservoir No. 3 (Depth at Place of Observation 20.5 Feet). | | | Lake Cochituate (Depth at Place of Observation 62.0 Feet). | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. | End of Open Channel. | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. |
| January, | 35.7 | 35.9 | 35.9 | 34.9 | 35.3 | 35.9 | 34.5 | 35.9 | 36.5 | 36.6 | 34.9 | 36.3 | 36.3 |
| February, | 34.5 | 35.0 | 35.5 | 35.4 | 36.4 | 37.0 | 34.1 | 35.7 | 36.3 | 37.1 | 36.5 | 36.9 | 37.1 |
| March, | 35.9 | 36.1 | 35.9 | 35.8 | 36.8 | 37.5 | 35.1 | 36.1 | 36.4 | 36.3 | 37.4 | 38.3 | 38.5 |
| April, | 42.0 | 41.9 | 41.2 | 44.6 | 44.6 | 44.5 | 42.5 | 47.9 | 47.6 | 47.3 | 45.0 | 43.0 | 42.0 |
| May, | 54.9 | 53.6 | 53.0 | 58.6 | 56.9 | 56.1 | 56.5 | 61.2 | 60.9 | 60.1 | 59.4 | 51.9 | 46.1 |
| June, | 69.3 | 68.8 | 68.3 | 68.0 | 64.8 | 61.8 | 65.8 | 71.3 | 70.0 | 68.8 | 68.1 | 54.9 | 47.0 |
| July, | 75.7 | 63.8 | 59.0 | 75.1 | 70.7 | 67.2 | 73.1 | 75.0 | 74.8 | 74.5 | 73.4 | 54.8 | 46.5 |
| August, | 78.3 | 65.5 | 60.9 | 76.8 | 74.4 | 71.8 | 70.6 | 77.5 | 76.3 | 75.6 | 76.0 | 55.5 | 46.8 |
| September, | 72.0 | 67.9 | 63.0 | 70.9 | 70.6 | 70.4 | 68.6 | 70.9 | 69.8 | 69.8 | 68.9 | 53.6 | 46.4 |
| October, | 61.0 | 58.9 | 56.3 | 59.5 | 59.7 | 59.9 | 58.6 | 58.0 | 58.1 | 58.2 | 57.3 | 53.6 | 46.3 |
| November, | 49.8 | 48.5 | 49.0 | 45.5 | 45.4 | 45.3 | 46.3 | 44.8 | 44.6 | 44.5 | 46.4 | 45.9 | 45.1 |
| December, | 34.7 | 36.0 | 36.0 | 33.3 | 33.6 | 34.6 | 34.0 | 35.0 | 34.5 | 35.0 | 36.0 | 36.5 | 36.8 |
| Mean, | 53.7 | 51.0 | 49.5 | 54.0 | 52.4 | 51.8 | 51.6 | 54.1 | 53.8 | 53.7 | 53.3 | 46.8 | 42.9 |

**Table No. 32 — *Concluded.***

[Degrees Fahrenheit.]

| Month. | Chestnut Hill Reservoir. | Spot Pond (Depth at Place of Observation 28.0 Feet). | | | Northern Service. | | Southern Service. | |
|---|---|---|---|---|---|---|---|---|
| | Effluent Gate-house No. 2. | Surface. | Mid-depth. | Bottom. | Tap at Glenwood Yard, Medford (Low Service). | Tap at Fire Station, Hancock Street, Everett (High Service). | Tap at 244 Boylston Street, Boston (Low Service). | Tap at 1 Ashburton Place, Boston (High Service). |
| January, | 36.2 | 34.6 | 34.7 | 35.0 | 39.0 | 37.4 | 40.7 | 40.2 |
| February, | 37.5 | 36.0 | 36.0 | 36.5 | 37.9 | 38.3 | 40.2 | 40.5 |
| March, | 36.8 | 35.6 | 35.9 | 36.0 | 37.9 | 37.4 | 39.6 | 37.7 |
| April, | 46.8 | 44.4 | 44.2 | 44.1 | 44.9 | 44.9 | 47.1 | 48.1 |
| May, | 59.2 | 57.9 | 57.9 | 56.4 | 56.1 | 57.6 | 59.9 | 61.0 |
| June, | 67.5 | 67.4 | 66.6 | 61.4 | 63.1 | 65.1 | 66.4 | 67.4 |
| July, | 75.0 | 73.6 | 73.2 | 64.4 | 69.0 | 71.9 | 71.6 | 74.1 |
| August, | 76.3 | 76.0 | 75.6 | 66.5 | 72.3 | 75.0 | 73.7 | 76.1 |
| September, | 70.4 | 70.4 | 70.4 | 70.0 | 68.9 | 69.4 | 70.4 | 71.2 |
| October, | 59.0 | 59.6 | 59.6 | 59.6 | 60.0 | 59.9 | 62.1 | 61.9 |
| November, | 45.5 | 45.1 | 45.3 | 45.4 | 49.5 | 47.3 | 49.3 | 48.7 |
| December, | 35.2 | 33.5 | 33.6 | 34.1 | 40.0 | 38.1 | 40.2 | 38.8 |
| Mean, | 53.8 | 52.8 | 52.8 | 50.8 | 53.2 | 53.5 | 55.1 | 55.5 |

TABLE NO. 33.— *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1906.*

[Degrees Fahrenheit.]

| Month. | Chestnut Hill Reservoir. | | | Framingham. | | | Clinton. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. |
| January, | 68.0 | 5.0 | 34.1 | 67.0 | 1.0 | 31.5 | 62.0 | 8.0 | 30.7 |
| February, | 61.0 | —1.0 | 29.9 | 59.0 | —6.0 | 27.3 | 53.0 | —6.0 | 25.5 |
| March, | 55.0 | 5.0 | 31.3 | 55.0 | 0.0 | 29.3 | 52.0 | 0.0 | 28.3 |
| April, | 74.0 | 26.0 | 47.1 | 75.0 | 21.0 | 46.0 | 74.0 | 22.0 | 45.1 |
| May, | 91.0 | 34.0 | 58.5 | 89.0 | 31.0 | 57.6 | 89.5 | 32.0 | 57.3 |
| June, | 88.0 | 43.0 | 67.2 | 88.0 | 38.0 | 65.5 | 86.0 | 38.0 | 65.3 |
| July, | 90.0 | 46.0 | 71.5 | 88.0 | 42.0 | 69.4 | 87.5 | 44.0 | 70.4 |
| August, | 94.0 | 49.0 | 73.5 | 92.0 | 44.0 | 70.9 | 90.5 | 46.0 | 71.0 |
| September, | 93.0 | 35.0 | 66.3 | 90.0 | 31.0 | 62.6 | 86.0 | 32.5 | 62.9 |
| October, | 73.0 | 28.0 | 53.7 | 73.0 | 22.0 | 49.7 | 70.0 | 25.0 | 50.0 |
| November, | 67.0 | 19.0 | 40.8 | 64.0 | 15.0 | 39.1 | 60.0 | 18.0 | 38.3 |
| December, | 50.0 | —1.0 | 27.2 | 48.0 | —6.0 | 24.2 | 48.0 | —4.0 | 23.3 |
| Average, | - | - | 50.0 | - | - | 47.8 | - | - | 47.3 |

TABLE No. 34. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same.*

| | Diameter of Pipes in Inches. | | | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60 | 48 | 42 | 36 | 30 | 24 | 20 | 16 | 14 | 12 | 10 | 8 | 6 | |
| Total length owned and operated January 1, 1906 (feet), | 9,069 | 171,163 | 8,075 | 46,638 | 26,922 | 46,680 | 57,059 | 54,394 | 26 | 19,353 | 614 | 1,633 | 858 | 442,484 |
| Gate valves in same, | - | 42 | - | 40 | 25 | 38 | 37 | 62 | 1 | 70 | 13 | 14 | 15 | 360 |
| Air valves in same, | 5 | 102 | 3 | 35 | 4 | 19 | 34 | 29 | - | 9 | - | - | - | 240 |
| Length laid or relaid during 1906 (feet), | - | 67 | - | - | - | 34 | 26 | 7 | - | 8 | - | 4 | 19 | 165 |
| Gate valves in same, | - | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 |
| Air valves in same, | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Length abandoned during 1906 (feet), | - | 67 | - | - | - | 60 | - | 7 | - | 8 | - | 4 | - | 146 |
| Gate valves in same, | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Air valves in same, | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Length owned and operated January 1, 1907 (feet), | 9,069 | 171,163 | 8,075 | 46,638 | 26,922 | 46,654 | 57,085 | 54,394 | 26 | 19,353 | 614 | 1,633 | 877 | 442,503[1] |
| Gate valves in same, | - | 42 | - | 40 | 28 | 39 | 37 | 62 | 1 | 70 | 13 | 14 | 15 | 361 |
| Air valves in same, | 5 | 102 | 3 | 35 | 4 | 19 | 34 | 29 | - | 9 | - | - | - | 240 |

[1] 83.80 miles.

TABLE NO. 35. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board.*

| | Diameter of Pipes in Inches. | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | 24 | 20 | 16 | 12 | 10 | 8 | 6 | 4 | |
| Total length in use January 1, 1907 (feet), . . . . | 352 | 288 | 2,250 | 4,421 | 178 | 315 | 2,684 | 1,144 | 11,632 |
| Total valves in use January 1, 1907, . . . . . | - | - | 18 | 75 | 1 | 1 | 54 | 38 | 187 |

TABLE No. 36. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works in 1906.*

| By whom Owned. | Inches. | | | | | | | | | | | | | | | | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60 | 48 | 42 | 40 | 36 | 30 | 28 | 24 | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 7 | 6 | 5 | 4 | Feet. | Miles. |
| Metropolitan Water Works. | 9,069 | 171,163 | 8,075 | - | 46,638 | 26,922 | - | 46,654 | 57,085 | - | 54,394 | 26 | 19,853 | 614 | 1,633 | - | 877 | - | - | 442,503 | 83.80 |
| Boston, | - | 35,052 | 16,813 | 23,104 | 43,376 | 89,151 | 244 | 77,432 | 94,654 | - | 202,753 | - | 1,199,259 | 153,137 | 605,780 | - | 1,300,103 | - | 68,935 | 3,909,858 | 740.50 |
| Somerville, | - | - | - | - | - | - | - | - | 3,596 | 387 | 3,537 | 8,037 | 79,220 | 48,286 | 93,830 | - | 196,546 | - | 20,456 | 453,895 | 85.97 |
| Malden, | - | - | - | - | - | - | - | - | - | - | - | 9,152 | 64,216 | 27,025 | 71,743 | - | 203,047 | - | 63,860 | 439,043 | 83.15 |
| Chelsea, | - | - | - | - | - | - | - | - | - | - | 2,380 | - | - | 39,501 | 27,235 | - | 131,152 | - | 8,491 | 208,759 | 39.54 |
| Everett, | - | - | - | - | - | - | - | 2,484 | 2,900 | - | 2,233 | 206 | 5,570 | 39,206 | 19,847 | - | 132,913 | - | 31,146 | 236,505 | 44.79 |
| Quincy, | - | - | - | - | - | - | - | - | 2,079 | - | 23,232 | - | 24,987 | 32,166 | 88,644 | 994 | 223,714 | 948 | 98,596 | 495,960 | 93.93 |
| Medford, | - | - | - | - | - | - | - | - | 673 | - | 6,775 | 9,784 | 26,172 | 33,609 | 70,570 | - | 93,349 | - | 38,992 | 279,924 | 53.02 |
| Melrose, | - | - | - | - | - | - | - | - | - | - | 5,178 | 2,920 | 24,527 | 14,619 | 23,764 | - | 110,216 | - | 63,021 | 244,245 | 46.26 |
| Revere, | - | - | - | - | - | - | - | - | - | - | 22,650 | 5,700 | 11,000 | 17,050 | 18,555 | - | 52,198 | - | 70,744 | 197,897 | 37.48 |
| Watertown, | - | - | - | | - | - | - | - | - | - | 400 | 12,127 | 5,959 | 4,169 | 19,261 | - | 113,981 | - | 12,726 | 168,623 | 31.94 |
| Arlington, | - | - | - | - | - | - | - | - | - | - | - | - | 31,804 | 20,086 | 22,758 | - | 83,578 | - | 30,419 | 188,595 | 35.72 |
| Milton, | - | - | - | - | - | - | - | - | - | - | 103 | 44 | 22,437 | 19,031 | 38,922 | - | 107,252 | - | 14,323 | 202,112 | 38.28 |
| Winthrop, | - | - | - | - | - | - | - | - | - | - | - | - | 4,019 | 4,960 | 19,329 | - | 26,283 | - | 75,928 | 130,519 | 24.72 |
| Stoneham, | - | - | - | - | - | - | - | - | - | - | - | - | 4,525 | 4,725 | 2,975 | - | 90,550 | - | 13,438 | 116,213 | 22.01 |
| Belmont, | - | - | - | - | - | - | - | - | - | - | - | - | 2,161 | 12,302 | 13,696 | - | 77,906 | - | 283 | 106,345 | 20.14 |
| Lexington, | - | - | - | - | - | - | - | - | - | - | - | - | 9,000 | 2,664 | 8,113 | - | 47,602 | - | 33,874 | 101,253 | 19.18 |
| Nahant, | - | - | - | - | - | - | - | - | - | - | - | - | 150 | 11,550 | 4,850 | - | 32,900 | - | 35,300 | 84,750 | 16.05 |
| Swampscott, | - | - | - | - | - | - | - | - | - | - | - | - | 12,072 | 13,634 | 13,217 | - | 50,357 | - | 9,110 | 98,390 | 18.63 |
| Total feet, | 9,069 | 206,215 | 24,888 | 23,104 | 90,014 | 116,073 | 244 | 126,570 | 161,587 | 387 | 323,635 | 47,996 | 1,546,431 | 498,284 | 1,164,722 | 994 | 3,074,524 | 948 | 689,702 | 8,105,387 | - |
| Total miles, | 1.72 | 39.06 | 4.71 | 4.38 | 17.05 | 21.98 | .05 | 23.97 | 30.60 | .07 | 61.30 | 9.09 | 292.89 | 94.35 | 220.59 | .19 | 582.30 | .18 | 130.63 | - | 1,535.11 |

**Table No. 37.** — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works in 1906.*

| City or Town. | Services. | Meters. | Fire Hydrants. |
|---|---|---|---|
| Boston, | 93,091 | 5,090 | 8,076 |
| Somerville, | 11,489 | 2,821 | 1,018 |
| Malden, | 7,081 | 6,583 | 428 |
| Chelsea, | 6,509 | 952 | 316 |
| Everett, | 5,090 | 101 | 515 |
| Quincy, | 5,857 | 834 | 701 |
| Medford, | 4,298 | 449 | 504 |
| Melrose, | 3,392 | 133 | 291 |
| Revere, | 2,802 | 183 | 141 |
| Watertown, | 1,845 | 1,814 | 332 |
| Arlington, | 1,940 | 652 | 364 |
| Milton, | 1,284 | 1,284 | 304 |
| Winthrop, | 1,973 | 45 | 120 |
| Stoneham, | 1,311 | 25 | 110 |
| Belmont, | 754 | 754 | 168 |
| Lexington, | 708 | 15 | 104 |
| Nahant, | 425 | 73 | 67 |
| Swampscott, | 1,259 | 476 | 136 |
| Total, | 151,058 | 22,233 | 13,690 |

TABLE NO. 38. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose, at Different Stations on the Metropolitan Water Works.*

| 1906. Month. | Low-service. | | | | | | | | | | | | | | Southern High-service. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boston Engine House, Bulfinch Street. | | Allston Engine House, Harvard Street. | | Medford, Mystic Reservoir. | | Medford Water Works Office, High Street. | | Somerville City Hall Annex, Walnut Street. | | Malden Water Works Shop, Green Street. | | Chelsea Water Works Office, Park Street. | | Boston Metropolitan Water Works Office, 1 Ashburton Place. | | Watertown Water Works Office, Main Street. | |
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, . | 143 | 129 | 186 | 176 | 168 | 165 | 168 | 166 | 168 | 162 | 162 | 159 | 161 | 152 | 248 | 236 | 264 | 261 |
| February, . | 137 | 125 | 185 | 174 | 169 | 165 | 168 | 165 | 168 | 162 | 163 | 159 | 158 | 148 | 248 | 237 | 263 | 259 |
| March, . . | 143 | 128 | 182 | 172 | 167 | 164 | 168 | 165 | 166 | 161 | 162 | 159 | 161 | 151 | 248 | 237 | 264 | 259 |
| April, . . | 146 | 126 | 186 | 175 | 168 | 164 | 168 | 165 | 167 | 162 | 163 | 160 | 163 | 154 | 249 | 236 | 264 | 258 |
| May, . . | 146 | 123 | 185 | 176 | 170 | 165 | 168 | 164 | 166 | 160 | 162 | 157 | 162 | 152 | 248 | 235 | 263 | 255 |
| June, . . | 143 | 122 | 184 | 174 | 169 | 164 | 167 | 162 | 166 | 159 | 164 | 159 | 165 | 153 | 247 | 234 | 262 | 255 |
| July, . . | 138 | 123 | 181 | 172 | 168 | 165 | 166 | 162 | 164 | 159 | 163 | 160 | 164 | 154 | 246 | 235 | 262 | 255 |
| August, . | 137 | 121 | 185 | 172 | 169 | 164 | 166 | 162 | 167 | 160 | 164 | 160 | 165 | 154 | 247 | 236 | 261 | 253 |
| September, . | 137 | 121 | 188 | 173 | 169 | 165 | 166 | 162 | 165 | 159 | 164 | 161 | 165 | 154 | 247 | 235 | 262 | 253 |
| October, . | 140 | 123 | 180 | 170 | 168 | 164 | 166 | 164 | 164 | 159 | 165 | 162 | 165 | 156 | 247 | 235 | 263 | 256 |
| November, . | 138 | 123 | 181 | 170 | 168 | 164 | 167 | 164 | 165 | 158 | 166 | 160 | 166 | 154 | 248 | 236 | 262 | 256 |
| December, . | 127 | 116 | 188 | 173 | 168 | 163 | 166 | 163 | 164 | 158 | 164 | 161 | 159 | 150 | 246 | 235 | 264 | 259 |
| Averages, | 140 | 123 | 183 | 173 | 168 | 164 | 167 | 164 | 166 | 160 | 164 | 160 | 163 | 153 | 247 | 236 | 263 | 257 |

TABLE NO. 38.—*Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.*—Concluded.

| 1906. MONTH. | SOUTHERN HIGH-SERVICE—Concluded. | | | | | | NORTHERN HIGH-SERVICE. | | | | | | | | NORTHERN EXTRA HIGH-SERVICE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BELMONT TOWN HALL, PLEASANT STREET. | | MILTON WATER WORKS OFFICE, ADAMS STREET. | | QUINCY WATER WORKS SHOP. | | SOMERVILLE PUMPING STATION, CEDAR STREET. | | MALDEN CITY HALL. | | REVERE WATER WORKS OFFICE, BROADWAY. | | LYNN ENGINE HOUSE, UNION SQUARE. | | LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE. | |
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, | 263 | 257 | 246 | 239 | 237 | 221 | 268 | 258 | 269 | 267 | 263 | 255 | 257 | 248 | 378 | 366 |
| February, | 263 | 258 | 246 | 240 | 236 | 221 | 268 | 257 | 270 | 266 | 262 | 254 | 262 | 254 | 376 | 363 |
| March, | 260 | 255 | 246 | 240 | 237 | 220 | 269 | 259 | 270 | 267 | 264 | 255 | 263 | 256 | 376 | 365 |
| April, | 260 | 253 | 247 | 237 | 238 | 220 | 264 | 250 | 265 | 261 | 260 | 249 | 259 | 248 | 383 | 366 |
| May, | 260 | 249 | 245 | 235 | 237 | 215 | 266 | 247 | 268 | 264 | 261 | 243 | 259 | 242 | 387 | 366 |
| June, | 261 | 251 | 244 | 233 | 236 | 210 | 268 | 246 | 269 | 264 | 261 | 232 | 259 | 225 | 386 | 366 |
| July, | 260 | 253 | 246 | 235 | 238 | 216 | 267 | 248 | 268 | 263 | 261 | 229 | 260 | 219 | 378 | 360 |
| August, | 260 | 253 | 245 | 235 | 237 | 213 | 268 | 248 | 267 | 262 | 259 | 225 | 255 | 216 | 382 | 363 |
| September, | 260 | 247 | 245 | 233 | 237 | 212 | 266 | 247 | 268 | 264 | 262 | 230 | 260 | 226 | 384 | 364 |
| October, | 261 | 253 | 246 | 236 | 239 | 218 | 266 | 250 | 270 | 266 | 265 | 252 | 264 | 250 | 384 | 367 |
| November, | 262 | 255 | 247 | 237 | 239 | 222 | 270 | 254 | 271 | 268 | 268 | 255 | 266 | 254 | 383 | 368 |
| December, | 263 | 259 | 245 | 237 | 236 | 221 | 269 | 256 | 272 | 268 | 264 | 253 | 263 | 252 | 381 | 369 |
| Averages, | 261 | 254 | 246 | 236 | 237 | 217 | 267 | 252 | 269 | 265 | 263 | 244 | 261 | 241 | 382 | 365 |

# APPENDIX No. 3.

## WATER WORKS STATISTICS FOR THE YEAR 1906.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

| CITY OR TOWN. | Population, Census of 1905. | Estimated Population July 1, 1906. |
|---|---|---|
| Boston, | 595,380 | 601,430 |
| Somerville, | 69,272 | 70,950 |
| Malden, | 38,037 | 39,040 |
| Chelsea, | 37,289 | 38,000 |
| Newton,[1] | 36,827 | 37,560 |
| Everett, | 29,111 | 30,270 |
| Quincy, | 28,076 | 28,300 |
| Medford, | 19,686 | 20,080 |
| Hyde Park,[1] | 14,510 | 14,720 |
| Melrose, | 14,295 | 14,650 |
| Revere, | 12,659 | 13,190 |
| Watertown, | 11,258 | 11,550 |
| Arlington, | 9,668 | 9,940 |
| Milton, | 7,054 | 7,120 |
| Winthrop, | 7,034 | 7,240 |
| Stoneham, | 6,332 | 6,350 |
| Lexington, | 4,530 | 4,730 |
| Belmont, | 4,360 | 4,410 |
| Nahant, | 922 | 930 |
| Total population of Metropolitan Water District, | 946,300 | 960,460 |
| Swampscott,[2] | 5,141 | 5,330 |
| Saugus,[3] | 200 | 200 |

[1] No water supplied to these places during the year from Metropolitan Water Works.
[2] Not in the Metropolitan Water District, but has been supplied with water from the Metropolitan Water Works.
[3] Only a small portion of Saugus is supplied with water.

*Mode of Supply.*

27 per cent. from gravity.
73 per cent. from pumping.

*Pumping.*

*Chestnut Hill High-service Station:* —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Quemahoning, Orenda, Georges Creek Cumberland, Peerless, Miller Vein, Vulcan Steam and Carbon. Anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4.09 to $4.79, buckwheat $2.93, screenings $2.52. Average price per gross ton $4.01. Per cent. ashes, 11.9.

*Chestnut Hill Low-service Station:* —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Quemahoning, Orenda and Carbon. Anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4 to $4.42, buckwheat $2.84, screenings $2.52. Average price per gross ton $3.82. Per cent. ashes, 13.4.

*Spot Pond Station:* —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Georges Creek Cumberland. Anthracite: screenings. Price per gross ton in bins: bituminous $4.35 and $4.38, screenings $2.24. Average price per gross ton $3.97. Per cent. ashes, 12.9.

| | Chestnut Hill High-service Station. | | |
|---|---|---|---|
| | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. |
| Daily pumping capacity (gallons), | 16,000,000 | 20,000,000 | 30,000,000 |
| Coal consumed for year (pounds), | 3,014,777 | 518,933 | 8,518,537 |
| Cost of pumping, figured on pumping station expenses, | $12,646.91 | $1,796.69 | $30,007.55 |
| Total pumpage for year, corrected for slip (million gallons), | 1,905.11 | 514.22 | 10,310.81 |
| Average dynamic head (feet), | 120.99 | 128.44 | 131.57 |
| Gallons pumped per pound of coal, | 631.92 | 990.91 | 1,210.40 |
| Duty on basis of plunger displacement, | 65,670,000 | 114,550,000 | 136,740,000 |
| Cost per million gallons raised to reservoir, | $6.638 | $3.498 | $2.910 |
| Cost per million gallons raised one foot, | 0.055 | 0.027 | 0.022 |

| | Chestnut Hill Low-service Station. Engines Nos. 5, 6 and 7. | Spot Pond Station. Engines Nos. 8 and 9. |
|---|---|---|
| Daily pumping capacity (gallons), | 105,000,000 | 80,000,000 |
| Coal consumed for year (pounds), | 7,955,358 | 2,533,049 |
| Cost of pumping, figured on pumping station expenses, | $32,004.96 | $12,205.04 |
| Total pumpage for year, corrected for slip (million gallons), | 18,938.59 | 3,031.77 |
| Average dynamic head (feet), | 51.15 | 127.98 |
| Gallons pumped per pound of coal, | 2,380.61 | 1,196.89 |
| Duty on basis of plunger displacement, | 104,520,000 | 131,600,000 |
| Cost per million gallons raised to reservoir, | $1.690 | $4.026 |
| Cost per million gallons raised one foot, | 0.033 | 0.031 |

*Consumption.*

| | |
|---|---|
| Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1906, | 913,710 |
| Total consumption (gallons), | 43,369,310,000 |
| Average daily consumption (gallons), | 118,820,000 |
| Gallons per day to each inhabitant, | 130.0 |

*Distribution.*

| | Owned and operated by Metropolitan Water and Sewerage Board. | Total in District supplied by Metropolitan Water Works. |
|---|---|---|
| Kinds of pipe used, | –[1] | –[2] |
| Sizes, | 60 to 6 inch. | 60 to 4 inch. |
| Extensions, less length abandoned (miles), | – | 14.16 |
| Length in use (miles), | 83.80 | 1,585.11 |
| Stop gates added, | 1 | – |
| Stop gates now in use, | 361 | – |
| Service pipes added, | – | 3,264 |
| Service pipes now in use, | – | 151,058 |
| Meters added, | – | 4,257 |
| Meters now in use, | – | 22,233 |
| Fire hydrants added, | – | 198 |
| Fire hydrants now in use, | – | 13,690 |

[1] Cast-iron and cement-lined wrought iron.
[2] Cast-iron, cement-lined wrought iron and kalamine.

# Appendix No. 4.

Contracts made and pending during

*Contracts relating to the*

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | Amount of Bid. 4. Next to Lowest. | 5. Lowest. | 6. Contractor. |
|---|---|---|---|---|---|---|
| 1 | 51 | Section 64, North Metropolitan System, Malden extension, 42-inch and 54-inch diameter, and 28-inch by 42-inch concrete sewer in open cut. | 4 | $39,388 50 | $33,577 80 | T. H. Gill & Co., Boston, Mass. |

*Contracts relating to the*

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 16 | Section 77, High-level Sewer, Roxbury, pumping plant for Ward Street pumping station. | 3 | $207,000 00 | $204,000 00 | Allis-Chalmers Co., Milwaukee, Wis. |
| 3 | 52 | Two horizontal return tubular boilers with masonry settings and connecting smoke flue for the Quincy sewerage pumping station. | 2 | 4,295 00 | 3,850 00 | Robb-Mumford Boiler Company, Boston, Mass. |

# Appendix No. 4.

THE YEAR 1906 — SEWERAGE WORKS.

*North Metropolitan System.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1906. | 10. Value of Work done December 31, 1906. | |
|---|---|---|---|---|
| Aug. 8, 1906, | - | For earth excavation and refill for 42-inch diameter sewer, $4.60 per linear foot; for 54-inch diameter sewer, $5.60 per linear foot; and for 28-inch by 42-inch sewer, $4.20 per linear foot. Portland cement brick masonry, $14 per cubic yard; Portland cement concrete masonry, $8 per cubic yard. Spruce piles driven and cut off below concrete, $0.25 per linear foot. Rock excavation in trench, $7 per cubic yard. Spruce lumber in place, $20 per M feet B.M. | $40,148 57 | 1 |

*South Metropolitan System.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1906. | 10. Value of Work done December 31, 1906. | |
|---|---|---|---|---|
| Jan. 17, 1902, | Dec. 12, 1906, | - - | $204,000 00 | 2 |
| Aug. 31, 1906, | - | - - | - | 3 |

CONTRACTS MADE AND PENDING DURING THE YEAR 1906 — SEWERAGE WORKS — *Concluded.*

## Summary of Contracts.[1]

| | Value of Work done December 31, 1906. |
|---|---|
| North Metropolitan System, 1 contract, | $40,148 57 |
| South Metropolitan System, 2 contracts, | 204,000 00 |
| Total of 3 contracts made and pending during the year 1906, | $244,148 57 |

[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

# APPENDIX No. 5.

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## FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 14, 1907.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the eleven months ending November 30, 1906, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

### METROPOLITAN WATER WORKS.

The appropriations under the Metropolitan Water Acts, the receipts which are added to these appropriations, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1906, have been as follows: —

| | | |
|---|---|---|
| Appropriations under Metropolitan Water Acts, | | $40,500,000 00 |
| Receipts from the sales of real estate, and from labor, tools and supplies, which are placed to the credit of the Metropolitan Water Loan Fund: — | | |
| For the eleven months ending November 30, 1906, | $17,506 01 | |
| For years previous to 1906, | 123,765 50 | |
| | | 141,271 51 |
| | | $40,641,271 51 |
| Amount approved for payment by the Board, out of the Metropolitan Water Loan Fund: — | | |
| For the eleven months ending November 30, 1906, | $1,219,883 78 | |
| For years previous to 1906, | 39,044,214 23 | |
| | | 40,264,098 01 |
| Balance December 1, 1906, | | $377,173 50 |

The amount approved by the Board for maintenance and operation of the Metropolitan Water Works during the eleven months ending November 30, 1906, was $356,159.77.

The following receipts, from sales of water to municipalities not belonging to the District and to water companies, have been distributed back to the towns and cities of the District by the Treasurer of the Commonwealth, as provided by section 3 of the Metropolitan Water Act: —

| | |
|---|---|
| For the eleven months ending November 30, 1906, . . . . . | $5,575 18 |
| For years previous to 1906 (including sums received from municipalities for admission to the District), . . . . . . . . | 214,290 47 |
| | $219,865 65 |

The Board has also received the following sums from rentals, land products and other sources, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works: —

| | |
|---|---|
| For the eleven months ending November 30, 1906, . . . . . | $6,667 65 |
| For years previous to 1906, . . . . . . . . . . . | 124,164 39 |
| | $130,832 04 |

## Metropolitan Sewerage Works.

The appropriations for the construction of the Metropolitan Sewerage Works, the receipts which are added to the appropriations, and the expenditures for construction, are given below, as follows: —

### North Metropolitan System.

| | | |
|---|---|---|
| Appropriations under the various acts, including those for the Revere, Belmont and Malden extensions, . . . . . . . . . . . | $6,160,865 73 | |
| Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the Metropolitan Sewerage Loan Fund: — | | |
| For the eleven months ending November 30, 1906, | - | |
| For years previous to 1906, . . . . . | 17,153 40 | |
| Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: — | | |
| For the eleven months ending November 30, 1906, | - | $39,754 65 |
| For years previous to 1906, . . . . . | - | 6,088,830 56 |
| | $6,178,019 13 | $6,128,585 21 |
| Balance, North Metropolitan System, December 1, 1906, . | | $49,433 92 |

[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

### South Metropolitan System.

*Charles River Valley Sewer.*

| | | |
|---|---|---|
| Appropriations under the various acts, . . . . | $800,046 27 | |
| Amount approved by the Metropolitan Sewerage Commission for payment to December 1, 1906, . | - | $800,046 27 |

*Neponset Valley Sewer.*

| | | |
|---|---|---|
| Appropriations under the various acts, . . . . | 904,000 00 | |
| Receipts for pumping, which are placed to the credit of the South Metropolitan System, . . . . | 109 50 | |
| Amount approved by Board for payment on account of the Neponset Valley Sewer: — | | |
| For the eleven months ending November 30, 1906, | - | 5,797 66 |
| For years previous to 1906, . . . . . | - | 905,733 80 |

*High-level Sewer.*

| | | |
|---|---|---|
| Appropriations under the various acts, . . . . | $7,163,000 00 | |
| Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: — | | |
| For the eleven months ending November 30, 1906, | 256 20 | |
| For years previous to 1906, . . . . . | 6,512 77 | |
| Amount approved by the Board for payments on account of the High-level Sewer: — | | |
| For the eleven months ending November 30, 1906, | - | 42,972 65 |
| For years previous to 1906, . . . . . | - | 5,918,262 59 |
| | $8,873,924 74 | $7,672,812 97 |

| | |
|---|---|
| Balance, South Metropolitan System, December 1, 1906, . | $1,201,111 77 |

For the maintenance and operation of sewerage works annual appropriations are made. The balances, appropriations and expenditures for the eleven months ending November 30, 1906, are as follows: —

### Maintenance of North Metropolitan System.

| | |
|---|---|
| Balance January 1, 1906, . . . . . . . . . . . . | $32,897 15 |
| Appropriated for the eleven months ending November 30, 1906, . | 115,986 50 |
| | $148,883 65 |
| Receipts from pumping and from other sources, which are returned to the appropriation: — | |
| For the eleven months ending November 30, 1906, . . . . | 1,013 43 |
| | $149,897 08 |
| Amount approved for payment by the Board: — | |
| For the eleven months ending November 30, 1906, . . . . | 105,880 85 |
| Balance December 1, 1906, . . . . . . . . . | $44,016 23 |

MAINTENANCE OF SOUTH METROPOLITAN SYSTEM.

| | |
|---|---|
| Balance January 1, 1906, | $139 99 |
| Appropriated for the eleven months ending November 30, 1906, | 87,375 00 |
| | $87,514 99 |
| Receipts from sales of property and for pumping, which are returned to the appropriation: — | |
| For the eleven months ending November 30, 1906, | 51 50 |
| | $87,566 49 |
| Amount approved for payment by the Board: — | |
| For the eleven months ending November 30, 1906, | 76,101 62 |
| Balance December 1, 1906, | $11,464 87 |

# APPENDIX NO. 6.

## LEGISLATION OF THE YEAR 1906 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

## ACTS OF 1906.

[CHAPTER 153.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

*Be it enacted, etc., as follows:*

SECTION 1. A sum not exceeding one hundred fifteen thousand nine hundred eighty-six dollars and fifty cents is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities and towns included in what is known as the north metropolitan system, during the eleven months ending on the thirtieth day of November, nineteen hundred and six. North Metropolitan system of sewage disposal.

SECTION 2. This act shall take effect upon its passage. [*Approved March 12, 1906.*

[CHAPTER 154.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

*Be it enacted, etc., as follows:*

SECTION 1. A sum not exceeding eighty-seven thousand three hundred and seventy-five dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, dur- South Metropolitan system of sewage disposal.

ing the eleven months ending on the thirtieth day of November, nineteen hundred and six.

SECTION 2. This act shall take effect upon its passage. [*Approved March 12, 1906.*

[CHAPTER 235.]

AN ACT RELATIVE TO THE ANNUAL REPORTS OF THE METROPOLITAN WATER AND SEWERAGE BOARD.

*Be it enacted, etc., as follows:*

Reports of Metropolitan Water and Sewerage Board.

SECTION 1. The metropolitan water and sewerage board shall, on or before the third Wednesday in January in each year, in accordance with the provisions of chapter two hundred and eleven of the acts of the year nineteen hundred and five, report to the general court an abstract of its receipts, expenditures, disbursements, assets and liabilities for the preceding fiscal year, as required by said act, together with all recommendations for legislation which it deems desirable, and shall in the month of February present a more detailed statement of its doings for the calendar year next preceding, the same to be printed as its annual report for the year.

SECTION 2. This act shall take effect upon its passage. [*Approved April 2, 1906.*

[CHAPTER 319.]

AN ACT TO PROVIDE FOR AN EXTENSION OF THE METROPOLITAN SEWER IN THE CITY OF MALDEN.

*Be it enacted, etc., as follows:*

The Metropolitan sewer to be extended in Malden.

SECTION 1. The metropolitan water and sewerage board shall extend the metropolitan sewer in Linden avenue, in the city of Malden, from a point near Waverly street, through Linden avenue, Pleasant street and private lands, Jackson street and private lands, to a point in the north metropolitan system about five hundred feet south of Charles street, and shall connect the same by overflow and proper appurtenances with the tidal flow of the Malden river.

Authority of the Metropolitan Water and Sewerage Board.

SECTION 2. For the purpose of constructing and maintaining this addition to the extension of the metropolitan sewers, the metropolitan water and sewerage board shall have and exercise all the authority conferred upon the metropolitan sewerage commissioners and their successors by chapter four

hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto, regarding the original system or anything relating thereto, and the provisions of said chapter and of such other acts are hereby made applicable to this additional construction unless herein otherwise provided.

**Treasurer and receiver general to issue bonds, etc.**

SECTION 3. To meet the expenses incurred under the provisions of this act for the construction of the sewerage work recommended, the treasurer and receiver general shall, with the approval of the governor and council, issue from time to time bonds, in the name and behalf of the Commonwealth and under its seal, to an amount not exceeding fifty-five thousand dollars. The provisions of section twelve of said chapter four hundred and thirty-nine and of acts in amendment thereof and in addition thereto relative to the indebtedness authorized by and incurred under that chapter, shall, so far as they may be applicable, apply to the indebtedness authorized by this act, in the same manner as if the said provisions had been inserted herein, except that any premiums which may be realized from the sale of said bonds shall be applied in the same manner in which the proceeds of the sale of such bonds, exclusive of the amounts received from premiums, are now applied.

**Interest and sinking fund requirements.**

SECTION 4. The interest and sinking fund requirements on account of the moneys expended in constructing the extension of the metropolitan sewer in Malden provided for in this act, and the cost of maintenance thereof, shall be deemed a part of the interest, sinking fund requirements and costs provided for by section fifteen of said chapter four hundred and thirty-nine, and shall be apportioned, assessed and collected in the manner provided by that chapter and by acts in amendment thereof or in addition thereto.

SECTION 5. This act shall take effect upon its passage. [*Approved April 28, 1906.*

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[CHAPTER 337.]

AN ACT RELATIVE TO PREMIUMS RECEIVED FROM THE SALE OF METROPOLITAN WATER LOAN BONDS.

*Be it enacted, etc., as follows:*

**Premiums from sale of securities to be paid into sinking fund.**

SECTION 1. Premiums received from the sale of bonds issued on account of the Metropolitan Water Loan, under section seventeen of chapter four hundred and eighty-eight of

the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, shall hereafter be paid into the sinking fund for the extinguishment of the principal indebtedness.

SECTION 2. This act shall take effect upon its passage. [*Approved April 30, 1906.*

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[CHAPTER 338.]

AN ACT RELATIVE TO PREMIUMS RECEIVED FROM THE SALE OF METROPOLITAN SEWERAGE LOAN BONDS.

*Be it enacted, etc., as follows:*

Premiums from sale of securities to be paid into sinking fund.

SECTION 1. Premiums received from the sale of scrip, certificates of debt or bonds, issued on account of the metropolitan sewerage works, shall hereafter be paid into the sinking fund for the extinguishment of the principal indebtedness.

SECTION 2. This act shall take effect upon its passage. [*Approved April 30, 1906.*

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[CHAPTER 367.]

AN ACT TO PROVIDE FOR AN ADDITIONAL METROPOLITAN WATER LOAN.

*Be it enacted, etc., as follows:*

Additional Metropolitan water loan.

SECTION 1. The treasurer and receiver general shall from time to time, upon the request of the metropolitan water and sewerage board, issue negotiable bonds in the name and behalf of the Commonwealth and under its seal, designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding five hundred thousand dollars in addition to the forty million dollars authorized to be issued under the provisions of section seventeen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and of chapter four hundred and fifty-three of the acts of the year nineteen hundred and one; and the provisions of said chapter four hundred and eighty-eight and of acts in amendment thereof and in addition thereto shall apply to this additional loan to the same extent as if the amount authorized by said act had been forty million five hundred thousand dollars instead of twenty-seven million dollars.

SECTION 2. This act shall take effect upon its passage. [*Approved May 8, 1906.*

[Chapter 369.]

AN ACT TO ESTABLISH THE BASIS FOR DETERMINING THE ANNUAL ASSESSMENTS UPON THE MUNICIPALITIES WITHIN THE METROPOLITAN SEWERAGE DISTRICTS FOR INTEREST AND SINKING FUND REQUIREMENTS AND COST OF MAINTENANCE AND OPERATION.

*Be it enacted, etc., as follows:*

Section 1. The proportions in which each of the cities and towns belonging in whole or in part to the north metropolitan and south metropolitan sewerage districts, respectively, shall annually pay money into the treasury of the Commonwealth to meet the interest and sinking fund requirements for each year, as estimated by the treasurer of the Commonwealth, and to meet any deficiency in the amount previously paid in, as found by said treasurer, shall be based upon the respective taxable valuations of the property of said cities and towns, as last established by the general court for the purpose of constituting a basis of apportionment for state and county taxes. **Proportion of expense of the Metropolitan sewerage system to be borne by cities and towns, etc.**

Section 2. The proportions in which each of the cities and towns belonging in whole or in part to the north metropolitan and south metropolitan sewerage districts, respectively, shall annually pay money into the treasury of the Commonwealth to meet the cost of maintenance and operation of the respective sewerage systems, as estimated by the metropolitan water and sewerage board and certified by the treasurer of the Commonwealth, and to meet any deficiency in the amount previously paid in, as found by said treasurer, shall be based upon the respective populations of said cities and towns as ascertained by the last preceding state or United States census. **Proportion of payments to be based on population, etc.**

Section 3. If less than the whole area of any city or town is included in either of said metropolitan sewerage systems, the valuation and population only of that part of the city or town which is included in either of said systems, as determined by the metropolitan water and sewerage board, shall be used as a basis in determining the proportion and amount which it shall pay as its share of interest and sinking fund requirements and of the cost of maintenance and operation of works. **Proportion when part of a city or town is included, etc.**

Section 4. The metropolitan water and sewerage board shall annually, in accordance with the provisions of the foregoing sections, determine for each system the proportion in which each of the cities and towns belonging in whole or in **The Metropolitan Water and Sewerage Board to fix the proportions, etc.**

part to such system, shall annually pay money into the treasury of the Commonwealth to meet the interest and sinking fund requirements and to meet the cost of maintenance and operation of such system, and shall transmit the determinations of the board to the treasurer of the Commonwealth.

Interest and sinking fund requirements.

SECTION 5. The amount of money required each year from every such city or town to meet the interest and sinking fund requirements and cost aforesaid for that system in which it is included, and the deficiency, if any, shall be estimated by the treasurer of the Commonwealth in accordance with the proportions as determined aforesaid by the metropolitan water and sewerage board, and shall be included and made a part of the sum charged to such city or town, and shall be paid by the city or town into the treasury of the Commonwealth at the time required for the payment of its proportion of the state tax.

Not to affect any decree of the supreme judicial court.

SECTION 6. This act shall take effect upon its passage, but shall not modify or affect any decree of the supreme judicial court heretofore made. [*Approved May 8, 1906.*

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[CHAPTER 404.]

AN ACT RELATIVE TO THE DISPOSITION OF THE MONEY RECEIVED FROM MUNICIPALITIES FOR ADMISSION TO THE METROPOLITAN WATER DISTRICT.

*Be it enacted, etc., as follows:*

Sums received to be applied to cost of connecting water pipes, etc.

SECTION 1. All sums of money which shall hereafter be received under section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, providing for a metropolitan water supply, for the admission of a city or town into the metropolitan water district, shall be applied to the payment of the cost of connecting such city or town with the pipes and works of the metropolitan water district, and after such cost is paid the balance shall be applied by the treasurer and receiver general to the sinking fund established for the payment of bonds issued on account of the metropolitan water district.

Repeal.

SECTION 2. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 3. This act shall take effect upon its passage. [*Approved May 21, 1906.*

[Chapter 406.]

An Act to provide for an extension of the south metropolitan sewer through the districts of West Roxbury, Brookline and Brighton.

*Be it enacted, etc., as follows:*

The South Metropolitan sewerage system to be extended, etc.

Section 1. The metropolitan water and sewerage board shall construct, maintain and operate as part of the south metropolitan system of sewage disposal, a sewer extending from the corner of Centre and Perkins streets in Jamaica Plain, through West Roxbury, Brookline and as far as Oak Square in Brighton, substantially as outlined in the fourth annual report of said board, and in part execution of the plan outlined in said report.

Certain powers conferred, etc.

Section 2. For the purpose of constructing and maintaining this additional sewer, the metropolitan water and sewerage board shall have and exercise all the authority conferred upon the metropolitan sewerage commissioners and their successors by chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and acts in amendment thereof and in addition thereto, and all the provisions of said chapter and other acts are hereby made applicable to this additional construction, unless herein otherwise provided.

Treasurer and receiver general to issue bonds, etc.

Section 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, with the approval of the governor and council, issue from time to time bonds in the name and behalf of the Commonwealth, and under its seal, to an amount not exceeding one million one hundred and seventy-five thousand dollars. The provisions of section fourteen of said chapter four hundred and twenty-four and of all acts in amendment thereof and in addition thereto relative to the indebtedness authorized by and incurred under that chapter shall, so far as they may be applicable, apply to the indebtedness authorized by this act, in the same manner as if the said provisions had been inserted herein. Any premium realized on the sale of said bonds shall be paid into the Metropolitan Sewerage Loan Sinking Fund, South System.

Certain provisions of law to apply.

Assessment and collection of interest, etc.

Section 4. The interest and sinking fund requirements on account of the moneys expended in constructing the extension of the south metropolitan sewer provided for in this act, and the cost and maintenance thereof shall be deemed a

part of the interest and sinking fund requirements and costs provided for in said chapter four hundred and twenty-four, and shall be apportioned, assessed and collected in the manner provided by that chapter and by acts in amendment thereof and in addition thereto.

SECTION 5. This act shall take effect upon its passage. [*Approved May 21, 1906.*

---

[CHAPTER 457.]

AN ACT RELATIVE TO THE APPORTIONMENT OF THE ANNUAL ASSESSMENTS REQUIRED FOR THE CONSTRUCTION AND MAINTENANCE OF THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

**Apportionment of cost to cities and towns in the Metropolitan water district to be based partly on valuation and partly on consumption of water.**

The treasurer of the Commonwealth, for the purpose of making the apportionment to the cities and towns in the metropolitan water district of the amount required in each year to pay the interest, sinking fund requirements and expenses of maintenance and operation of the metropolitan water system provided for by section nineteen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, as amended by chapter four hundred and eighty-nine of the acts of the year nineteen hundred and one, shall, in the year nineteen hundred and seven, and in each year thereafter, apportion such amount to the cities and towns in said district, one third in proportion to their respective valuations for the preceding year and the remaining two thirds in proportion to the consumption by the cities and towns, respectively, in the preceding year, of water received from all sources of supply as determined by the metropolitan water and sewerage board, and certified to said treasurer: *provided, however,* that there shall be included in reckoning such proportion only one fifth of the total valuation, and nothing for consumption of water, for any city or town which has not reached the safe capacity of its present sources of supply or of the sources of supply of the water company by which it is supplied, determined as aforesaid, or which has not made application to said board for water; and *provided, further,* that any city or town assessed upon its full valuation which obtains a part of its water supply from its own works or receives a supply from a water company shall be allowed and credited in its apportion-

**Provisos.**

ment with a sum equal to twelve dollars for each million gallons of water furnished as aforesaid, as determined by said board and certified to said treasurer. The treasurer shall annually notify each city and town of the amount of its assessment, and the same shall be paid by the city or town into the treasury of the Commonwealth at the time required for the payment of and as part of its state tax. [*Approved June 6, 1906.*

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[CHAPTER 498.]

AN ACT TO MAKE EFFECTIVE THE AWARD OF THE COMMITTEE APPOINTED BY THE GOVERNOR TO DETERMINE THE DAMAGES CAUSED TO THE TOWN OF CLINTON BY THE CONSTRUCTION OF THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

SECTION 1. The treasurer of the Commonwealth shall pay to the town of Clinton as a part of the expense of the metropolitan water system, the sum of sixty-four thousand nine hundred and eighty-eight dollars on or before the fifteenth day of November in the year nineteen hundred and six. **A certain sum to be paid to the town of Clinton on account of construction of the Metropolitan water system.**

SECTION 2. All property held by the metropolitan water and sewerage board, or its successors, in the town of Clinton, outside of the dam and dike, used in the generation or sale of electricity for power or for manufacturing purposes, shall be subject to taxation. The provisions for the assessment and collection of taxes contained in chapters twelve and thirteen of the Revised Laws shall apply to such property. **Taxation.**

SECTION 3. All acts and parts of acts inconsistent herewith are hereby repealed. **Repeal.**

SECTION 4. This act shall take effect upon its passage. [*Approved June 18, 1906.*

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[CHAPTER 500.]

AN ACT TO PROVIDE FOR IMPROVEMENTS AND ADDITIONS AT CERTAIN STATE INSTITUTIONS.

*Be it enacted, etc., as follows:*

SECTION 1. To provide funds for the construction or enlargement of certain public institutions hereinafter named, . . . **Prisons and hospitals loan.**

Trustees of the Westborough insane hospital.

SECTION 2. From the aforesaid loan expenditures may be made as follows: —

. . . . . . . . . . . . . . . . . . . . . .

By the trustees of the Westborough insane hospital, a sum not exceeding forty thousand dollars, for the following purposes: — For constructing and furnishing buildings for tuberculous patients, a sum not exceeding five thousand dollars, and for obtaining and installing a new water supply, a sum not exceeding thirty-five thousand dollars; and the said trustees and the metropolitan water and sewerage board are authorized to arrange for taking water from the metropolitan aqueduct, so-called, near the said hospital, upon such terms as the said trustees and the said board may establish: *provided, however,* that the rate to be charged for the water used therefrom for the said hospital shall not exceed thirty dollars per million gallons.

Proviso.

. . . . . . . . . . . . . . . . . . . . . .

SECTION 3. This act shall take effect upon its passage. [*Approved June 20, 1906.*

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[CHAPTER 517.]

AN ACT TO CONSTITUTE EIGHT HOURS A MAXIMUM DAY'S WORK FOR PUBLIC EMPLOYEES.

***Be it enacted, etc., as follows:***

Eight hours to constitute a day's work for public employees, etc.

SECTION 1. Eight hours shall constitute a day's work for all laborers, workmen and mechanics now or hereafter employed, by or on behalf of the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws; but in cases where a Saturday half-holiday is given the hours of labor upon the other working days of the week may be increased sufficiently to make a total of forty-eight hours for the week's work.

Contracts to contain a certain stipulation, etc.

SECTION 2. Every contract, excluding contracts for the purchase of material or supplies, to which the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, is a party which may involve the employment of laborers, workmen or mechanics shall contain a stipulation that no laborer, workman or mechanic in the employ of the contractor, sub-contractor or other person doing

or contracting to do the whole or a part of the work contemplated by the contract shall be required to work more than eight hours in any one calendar day.

To whom the act shall apply.

SECTION 3. This act shall apply to all laborers, workmen or mechanics engaged upon any works which are or are intended to be the property of the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, whether such laborers, workmen or mechanics are employed by public authority or by a contractor or other private person.

Penalty.

SECTION 4. Any agent or official of the Commonwealth or of any county, city or town who violates any provision of this act shall be subject to a penalty of fifty dollars for each offence.

Not to apply to certain persons.

SECTION 5. The provisions of this act shall not apply to or affect contractors or sub-contractors for work, contracts for which were entered into prior to the passage of this act.

Repeal.

SECTION 6. So much of any act as is inconsistent herewith is hereby repealed.

SECTION 7. This act shall take effect upon its passage. [*Approved June 22, 1906.*

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[CHAPTER 530.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO SELL CERTAIN PROPERTY FOR THE RELOCATION OF A PUBLIC WAY IN THE TOWN OF FRAMINGHAM.

*Be it enacted, etc., as follows:*

Property held by the Commonwealth in the town of Framingham may be sold, etc.

SECTION 1. The metropolitan water and sewerage board may, in its discretion sell, lease or exchange by public or private sale any property of the Commonwealth held and used for water supply purposes, situated in the town of Framingham, southerly of and abutting on or adjacent to the Boston and Worcester turnpike, so-called, whether taken by the Commonwealth by eminent domain or otherwise, if such property is deemed necessary for the alteration, relocation or widening of any public way upon which said property abuts, and is not deemed necessary by said board for public purposes.

SECTION 2. This act shall take effect upon its passage. [*Approved June 27, 1906.*

[Chapter 533.]

An Act to provide for certain annual payments to the town of Holden on account of the construction of the metropolitan water system.

*Be it enacted, etc., as follows:*

Certain sums to be paid annually to the town of Holden, etc.

Section 1. The treasurer of the Commonwealth shall pay annually, as a part of the expenses of the metropolitan water system, on or before the thirty-first day of December, to the town of Holden an amount equal to the average assessment made by the assessors of said town for the three years preceding the purchase of said property by the Commonwealth on all real estate taken or acquired and held by the Commonwealth as a part of the metropolitan water system, on the first day of May in each year, such payment to be in place of taxes, and any other payments required by law on such property: *provided,* that, if any buildings standing on land taken or acquired and held by the Commonwealth, as aforesaid, are removed and remain in said town, the value of such buildings, as newly located, shall be deducted by the assessors from the said amount. The words "real estate" as used in this section shall include water rights, and in the case of mills, all machinery therein.

Proviso.

Words "real estate" defined.

Section 2. This act shall take effect upon its passage. [*Approved June 29, 1906.*

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[Chapter 536.]

An Act in addition to the several acts making appropriations for sundry and miscellaneous expenses authorized during the present year.

*Be it enacted, etc., as follows:*

Appropriations.

Section 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the Commonwealth from the ordinary revenue, except as otherwise provided herein, for the purposes specified in certain acts and resolves of the present year, and for certain other expenses authorized by law, to wit: —

. . . . . . . . . . . . . . . . .

Town of Clinton.

For the town of Clinton, being an award for damages caused by the construction of the metropolitan water system, as pro-

vided for by chapter four hundred and ninety-eight of the acts of the present year, the sum of sixty-four thousand nine hundred and eighty-eight dollars, to be paid out of the Metropolitan Water Maintenance Fund on or before the fifteenth day of November of the present year; said sum to be assessed on the metropolitan water district by the treasurer and receiver general during the present year.

. . . . . . . . . . .

SECTION 2. This act shall take effect upon its passage. [*Approved June 29, 1906.*

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AFFECTING THE

# METROPOLITAN WATER AND SEWERAGE BOARD.

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## A.



## B.



## C.



## E.

## S.



## T.



## W.